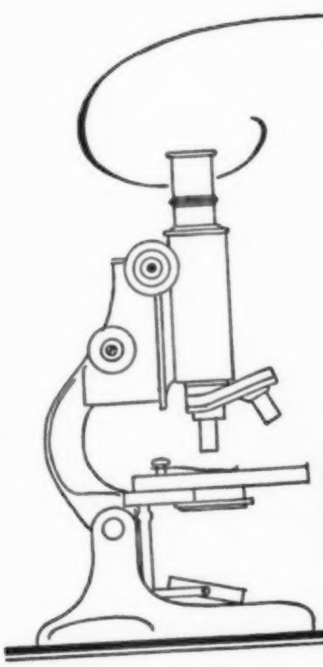

The SCIENCE COUNSELOR

A Quarterly Journal for
Teachers of Science in
the Catholic High Schools

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DEC., 1938

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The Science Counselor

"FOR BETTER SCIENCE TEACHING"

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Volume IV. DECEMBER, 1938 No. 4

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Science . . .

I see a universe in a drop of rain;
I measure eons with a ray of light,
And read the molten stars that jewel the night.
I catch the crackling lightning's golden chain
And tie the mountains of the tossing main.
I soar above them. In my dizzy flight
The birds are playthings and the clouds bedight
Beneath me in the sunshine's dappled stain.
Pain I assuage and gentle rest I bring
To eyes sad, weary in a world of sin;
Light through the darkness now gleams out anew
And laughter shakes the withered heart where Spring
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The splendid vision Faith unfolds for you.

• **By T. P. Gaynor, M.A.,** *(University of Notre Dame)*
DEPARTMENT OF ENGLISH, DUQUESNE UNIVERSITY

Notes from Ten Years' Experience as a Teacher of High School Chemistry

● By Sister M. Hildebert, S.C., M.S., *(Duquesne University)*
SETON HILL COLLEGE, GREENSBURG, PA.

What does the conscientious high school teacher of chemistry think about her work? What does she discover from her contacts with subject matter and pupils? Over a period of years what does she learn about teaching chemistry?

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"And whatever you do," said my friends in London, "write down your first impressions."

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I thank you, dear Editor, for affording me the opportunity to air my views on some of the problems which confront educators. You have also given me a splendid chance to take an inventory of my scientific resources and teaching procedures. Limited space restricts an exhaustive discussion. Besides, so much has been said and written about the problems which I should like to consider, that even those deeply interested in chemistry would grow more weary than I feel they already are. I ask you to permit me to present some brief notes, rather than to attempt anything like a formal survey.

In our round-table discussions and symposia we are continually displaying the confusion and uncertainty which permeate our curriculum. We try to come to the aid of the teacher in the laboratory. We try to tell her how, for instance, she may help and encourage the slow pupils while fostering the spirit of research in the more gifted and ambitious. It is a problem difficult to solve. She asks, "Which is to be preferred, the lecture demonstration method or the individual laboratory method?" We try to compromise and say, "Both methods have their advantages and disadvantages."

There has been general discussion of the question, "What should be our objectives in teaching chemistry?", and it has proved difficult to find an answer satisfactory to everyone. Anyone who has been pressed to answer must immediately recognize the comprehensive and significant scope of the aims of high school chemistry. Regard for highly specialized powers, habits, skills and abilities, a stress on the scientific attitude, preparation of the boys and girls for life problems, preparation for college, all these and a great deal more, demand place among the objectives. It has been contended that the teaching of chemistry should be concerned with the presentation of chemistry as a cultural subject.

Professor B. S. Hopkins says that chemistry demands of its students "a carefully trained memory, the ability to observe thoughtfully and intelligently, the power to discriminate between vital facts and non-essentials, and . . . the skill to interpret the significance of phenomena and to apply new knowledge to useful ends." In spite of the needs of the majority, emphasis on the teaching of chemistry seems particularly important. What has been reported by the committee on the training of physicists for industry, can be reported here concerning chemistry. "In elementary laboratory work the primary objective is understanding of basic principles; the technic of measurements should be looked upon as a means, not an end. To avoid stifling initiative, self-reliance, and interest, instructions as to procedure should not be too detailed. The experiments selected should lead to interesting and significant results. Nothing contributes more to these ends than the attitude of the instructors in charge of the work. Enthusiasm for this fundamental training is quite contagious. So is the lack of it."

During the last two decades, interest in chemistry has been growing. It is a mistake, however, to assume that the antipathy which many pupils entertain for the subject, has been outgrown. Who or what is responsible? . . . True, chemistry is an abstract sort of thing. Inasmuch as it is abstract, pupils who have little power in abstract thinking, as well as those who cannot visualize readily, will find chemistry an almost impossible lesson. It is generally agreed, however, that elementary chemistry is not too difficult for the average pupil. I think the distaste which the pupil has for this science is in some measure due to the unattractive way in which chemistry is too often presented.

At present, we know better how to interest our boys and girls, and it should not be difficult to agree upon the features by which the desired end may be attained. I think the strongest appeal is through the presentation of the utilitarian side of the subject. Without interfering with the systematic teaching of the science, without excessive digression, we can teach fundamental principles, using in numerous ways practical materials from every day life. This brings us to a consideration of the project method. Teachers must be careful not to abuse this activity method.

To quote Stanwood Cobb, one of the founders of the Progressive Education Association:

"A common defect in the use of the activity projects is the neglect to assure definite cultural

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Nutrition Experiments

● By Sister M. De la Salle, D.P., B.S., *(Duquesne University)*
DIVINE PROVIDENCE ACADEMY, PITTSBURGH

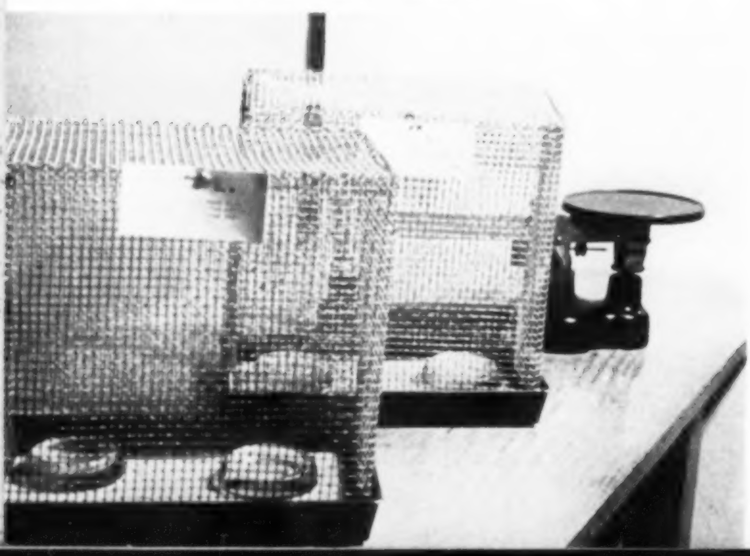
The teaching of biology is often criticized, and justly so, because it has too little "life" in it. The good teacher realizes this weakness and tries to guard against it.

Sister De la Salle has found a practicable way of transferring work in nutrition from the classroom to the laboratory, thereby adding greatly to its value and attractiveness.

To biology teachers she furnishes at least one solution to the problem of discovering devices that will arouse pupil interest and enthusiasm, sustain that interest, and at the same time demonstrate a connection between the subject matter of the textbook and the experiences of everyday life.

Realizing the part that proper nutrition plays in the well being of the individual, the family, and the race, the teacher is fully aware of the importance of giving students at least a fundamental understanding of the principles of nutrition and an appreciation of the findings of science in this field. The teacher's conviction, however, is no guarantee that the students will enthusiastically approach the study of the subject, and finish it with a full and complete knowledge of everything they should know about it. Unfortunately, the vitamins, carbohydrates, proteins, and other nutrients are rather uninteresting in themselves, and unless high school students are interested, the work of teaching is doubly hard and yet not successful. But when the vitamin or nutrient is being studied in its effects on a real, live, amusing little animal, the teacher's work becomes a pleasure. If the unit on nutrition is transferred from the recitation room to the laboratory, it easily becomes one of the most interesting in the course. And it can be done!

Home-made Animal Cages



The cost of equipment has probably had most to do with keeping nutrition experiments out of the biology laboratories of our high schools. To purchase the necessary cages, feeding dishes, scale, and other materials listed in any scientific supply catalogue would involve an amount considerably more than the ordinary budget allows for expenditures of this kind. We found, however, that the necessary equipment can be provided at so small a cost as to be almost negligible, considering that the same set-up may be used year after year with no maintenance expense.

An entirely satisfactory cage can be made in a few minutes, at a cost of about fifteen cents. A pan, 10.5" x 6.5" x 1.25", purchased at the five-and-ten-cent store for a nickel, serves as the base of the cage. The upper part is made of quarter-inch mesh which costs seven cents a square foot. This mesh comes in several standard widths. We bought the thirty-inch width and had it cut into three pieces, each having a width of ten inches. All that is necessary is to cut a piece of wire mesh the required length, allowing about three-fourths of an inch for fastening, and bend it so as to fit into the pan. Next cut a piece of mesh 11" x 7", bend in one-half inch all around, and fit it into the top of the cage. Fasten this at the corners with small pieces of wire and the cage is finished.

Rusting of the pan may be prevented by pouring a little wax into it. At the same time, the wax makes the pan still easier to keep clean. We use sawdust to absorb moisture. This is renewed each morning, and the cages are at all times clean and odorless. We use medium size caster cups for feeding dishes. These are heavy enough to prevent the animal's upsetting them and large enough to hold a day's supply of water or food. There are probably many other things that would be just as satisfactory, but we happened to have a number of caster cups accumulating dust in the storage room. A scale for weighing the animals is the only other piece of equipment necessary. The triple beam balance, already a part of our general laboratory equipment, answered this purpose very well.

The experiments were the suggestions of the pupils themselves. They were simple. Every member of the class knew just what was being done and what results were being obtained. Before beginning the work we used part of a recitation period to list possible experiments and select the ones favored by the majority. These were as follows:

1. To show the effect of excluding vitamin "A" from the diet.
2. To show the value of milk in the diet.
3. To show the effect of cod liver oil in the diet.
4. To show the effect of excluding vitamin "C" from the diet.

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What the Public Expects of Science Education

● By Harry E. Gill, Ph.D., *(University of Pittsburgh)*
DEPARTMENT OF CHEMISTRY, PEABODY HIGH SCHOOL, PITTSBURGH

Have you ever given serious thought to the desirable outcomes that the public has a right to expect from the teaching of science in high schools?

What are the benefits, other than preparation for college, that may be derived from science courses?

There are many.

Here a successful teacher of science in a public high school discusses the matter in a way that shows how much thoughtful consideration he has given to the question. You will be interested in his views, and impressed by them.

●

The dominant belief that prevailed years ago that the primary purpose of secondary education was to prepare for college has long since been abandoned. The people of the United States are no longer content with a strictly academic curriculum. They are demanding one which is adapted to the interests, the abilities, and the needs of their children.

In spite of the new trend, college preparation unquestionably will continue to be an important function of the secondary school, and the public has a right to expect a thorough, thought provoking, intensive preparation in science for their college preparatory group. Many decry the deletion of our former full, rich, formal courses in the major sciences to the point that they may be taken by anyone in high school, regardless of his mental potentialities, with little chance of failure.

Numerous wise curricular changes have been made because of the changing complexion of our high school population, and science should lead the way in adapting its courses to the needs of the pupils. Certainly, instruction in so important and popular a field as science should not be limited to those of the academic level; neither should the more advanced courses be destroyed to care for the indolent or low I. Q. pupils.

The public has a right to demand popular courses in science which will satisfy the diverse interests and abilities of their children, and make every one of them conscious of the fundamental principles of the subject and of the contributions which science has made and is likely to make to human advancement and welfare. To place properly and provide properly for each individual may require segregation through guidance and the teaching of the same subject on several ability levels, or it may necessitate the introduction of totally new courses.

But why not broaden the science curriculum instead of restricting it? Broaden it so all may profit from this form of learning.

Recent years have witnessed a diminution of time allotted to science, and especially to the laboratory phase, in secondary schools. The trend toward less laboratory time is due to two main causes. The one is scheduling; the other is the result of studies which seem to prove that demonstrations are as effective as laboratory work. These conclusions were based upon measurements of mastery of factual material. But are there not certain intangible appreciations, skills, and techniques established in the laboratory that cannot readily be measured? Parents believe there are, and studies of pupil reactions lead to the same conclusion. Is it not a paradox to teach scientific method, especially that portion dealing with suspended judgment until sufficient data have been accumulated, and deny the pupil the privilege of seeking scientific data in the laboratory?

Motivation has been the theme of education for many years. What motivating force can any subject offer that will approach that of the science laboratory? But, the time and, sometimes, the space factor prohibit its use. Today, a search is on for things which pupils may do with their hands, such as manual training, pottery, art, metal crafts, and others. May the laboratories not be the answer for those interested in science? Many hope that if scheduling prohibits the extension of time devoted to our present courses, some additional, strictly laboratory, courses may be offered.

What are a few of the benefits, other than preparation for college, which may be derived through a study of the sciences?

The mastery of factual material is one. Information about the common things learned in nature study, botany, zoology, chemistry, physics, and physical geography, leads to a more complete understanding of our environment and makes life richer and more worth while. If you doubt that the public is interested in such information, just pause for a moment to recall the hordes of people who crowded the Hall of Science at the Century of Progress Exposition in Chicago, to consider the space devoted to science in our papers and periodicals. Our publications are catering to a popular demand; so should we, by establishing a not too technical, factual, background of the common phenomena of science to the end that the public of the future may indulge in such reading with a greater understanding and sense of satisfaction.

The public should expect our secondary school science courses to have vocational exploration values. Our

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The Habits and Instincts of Ants

● By Reverend John A. Frisch, S.J., Ph.D., *(Johns Hopkins University)*
DEPARTMENT OF BIOLOGY, CANISIUS COLLEGE, BUFFALO, N. Y.

Father Frisch here continues his study of Ants. This paper studies their habits. The concluding article of the group, dealing more fully with instincts, will appear in our next number.

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I will confine myself to an investigation of some of the more general habits of ants, basing my account on personal studies of observation nests of the Carpenter ants, particularly *Camponotus pennsylvanicus.*

This ant builds its nest in the trunks of dead trees, or in the dead wood of living trees. The nest is a maze of branching and anastomosing excavations, consisting of more or less spacious chambers connected with one another by tubular tunnels or galleries. These galleries often continue down into the soil, especially in arid regions where the wood dries out during the summer. The chambers serve as nurseries for the brood and also for the assemblage of ants. A mature nest may contain over 2,000 individuals.

The workers are of several sizes: *(a)* large forms, resembling the queen and endowed with large heads and formidable mandibles, called major workers or soldiers; *(b)* smaller and more slender forms, with smaller heads, known as minor workers; and *(c)* very small forms, known as minim workers.

The observation nests were of several kinds: *(a)* closed nests, consisting of a wooden frame between two plates of glass, one plate forming the floor of the nest and the other the roof. The enclosed space was divided into several communicating chambers by wood partitions. A black cloth placed on the roof kept the nest in darkness. A much smaller nest, communicating with the large nest, served as a feed box; it was always kept uncovered; *(b)* open nests, identical with the closed nests, except that the nests were placed on a platform of wood, 14" x 18" in size. The platform was either supported on stilts over a pan of water somewhat larger than the platform, or it was surrounded by a tin trough about one inch wide filled with water, which formed a moat around the platform. The nest was provided with one or more exits which allowed the ants to come out and wander about the platform. The so-called bulldog ants are fond of water, even bathing in it; but most ants, Camponotus included, avoid water, though individuals will at times blunder into it, and in their struggles reach the opposite shore and escape.

When the colony is brought in from the field and placed on the platform, there is great confusion and much running about. Many tumble into the water, the momentum of their headlong pace making it impossible for them to stop in time. But very shortly some of them find the dark security of the nest. Apparently the news of the find is passed around, and more and more individuals enter the nest. But the process is too slow to suit some individuals and soon, all over the platform, you find these individuals pulling their sisters by the mandibles towards the nest entrance. The sight is particularly amusing when a minim worker, hardly one-quarter of an inch long and one-sixteenth of an inch wide, is pulling a queen fully an inch long with an abdomen three-sixteenths of an inch wide.

The same thing happens in nature when a colony is moving to a new nest and some of the members decide that the old nest is good enough for them and they insist on staying there. They are dragged and often literally carried to the new nest. Toward nightfall the returning foragers are often seen carrying one of their own, probably a worker too weary to come home under his own power. The carrier ant seizes the ant to be carried by the mandibles and holds her with back directed forward and downward and head uppermost, while the one being carried curls up her body and draws up her legs.

THE ROUTINE WORK OF AN ANT COLONY

The activities of a colony are many, among them being the guarding of the nest, the excavating or construction of galleries and chambers in the necessary enlargement of the nest, the foraging for food and the bringing home of the booty, the care of the brood, and the removal of the refuse of the colony to an obscure corner of the nest or to the exterior.

Whether all ants engage in all these occupations, or whether certain tasks are the duties of certain individuals, is a disputed question. Lubbock is of the opinion that the first occupation an ant engages in

after emerging from her pupal shell will be her specialty during life. Wheeler seems to hold that the first task of the callows is nursing, and that they do not engage in any other occupations until their armor has hardened sufficiently to protect them.

A certain distribution of labor is, however, evident. In the observation nests the care of the brood, the enlarging and cleaning of the nest, and most of the feeding were taken over by the minor and minim workers; the guarding of the nest and the fighting were done by the soldiers.

HABITS OF CLEANLINESS

I placed a wad of cotton, soaked in benzene, in a closed nest containing soil. The ants became frantic; some of them pulled off bits of the cotton and tried to carry it out of the nest; others brought particles of soil and piled them around the cotton, until the fumes drove them off.

I squirted a pool of water in front of the exit of the nest, thus preventing the ants from leaving the nest. Again much excitement, but soon the water disappeared under a heap of soil particles, and the way out was clear.

A colony of ants was placed in a closed nest with considerable soil and debris. The soil and debris were removed to the feed box. After a week, the nest was placed on a platform surrounded by a water moat. The ants brought out the soil and refuse from the feed box and scattered it indiscriminately on the platform. About an hour later, a single individual began to pick up the debris and carry it to the edge of the platform. There, leaning out as far as possible, she dropped the particles into the water. Others soon imitated her example. At first they dropped their burden into the water at any point, wherever they reached the edge of the platform. The next time I observed the colony, the ants were all dropping the particles into the water at the same point, and they had all but completed a bridge of soil across the width of the water moat.

The above observations indicate that any foreign matter found in the nest, particularly if noxious, is removed from the nest, or, if that is impossible, is buried; that anything objectionable placed in their path is likewise buried; that the refuse of the nest is deposited at a definite place, either within the nest or above ground. Such accumulations are known as kitchen middens. Was the filling of the water moat with soil particles an intelligent attempt at bridge building? No, just the kitchen midden habit.

CO-OPERATION

On several occasions I noticed the ants working in pairs, one bringing the nest refuse to the exit and dropping it on the platform, whilst another picked it up from there, carried it to the edge of the platform and dropped it into the water.

A small potted locust tree was placed on the platform. Later I discovered the ants digging furiously in the soil, apparently intending to establish their home there. The excavators carried the soil to the edge of the pot and dropped it down onto the platform. Another crew, down below, picked it up and carried it to the water.

FORAGING

Camponotus pennsylvanicus is omnivorous, and I fed her on honey, bits of dates, figs, cake, flesh and insects. In the observation nests only 5 or 6 ants a day, usually minor and minim workers, patronized the feeding dish, though the colonies contained as many as 200 individuals. The feeders would return home and feed the hungry members by regurgitation. One minim worker, recognizable by a slightly defective antenna, was observed feeding daily for two weeks, which would indicate that the same individuals do the feeding each day. But I had trained her to accept honey from the tip of my finger, which may account for her daily foraging. I am inclined to believe that the members of the colony forage at any time hunger moves them.

Whenever I disturbed the privacy of the nest by lifting the black cloth that covered the nest, I observed from 5 to 20 ants, mostly soldiers, standing in a semicircle facing the entrance of the nest, and quite separated from the main body of the colony. At the sudden admission of light they would open their mandibles, and move about uneasily. Some of them would retreat to the main body. For a time I considered the semicircle of ants a guard-line, ready to attack any invader of the nest.

One day I raised the cloth just as a forager entered the nest. On the instant the semicircle of supposed guards closed in on her, begging with antennae for food. The forager obligingly regurgitated drop after drop to the beggars. The guard-line had turned out to be a bread-line, though it is quite likely that it also functions as a guard-line.

CARE OF THE YOUNG

The ants attend to their young from the time the egg is laid until the fully formed adult emerges from the cocoon. The brood is segregated, the eggs, larvae and cocoons being placed in separate piles, either in the same or in different chambers; the larvae and pupae are again sorted into several piles according to size.

In general, the smaller the worker, the more it confines its work to the care of the brood. The nurses frequently lick the eggs, and it is possible that some of the saliva is absorbed. At any rate the saliva causes the eggs to adhere to one another, which allows them to be transported in packets when danger threatens. It may also have some antiseptic qualities that prevent the growth of molds.

The larvae of the Carpenter ants are fed by regurgitation and are kept scrupulously clean. In order to spin the cocoons, the larvae must be surrounded with particulate matter, between which they can suspend the scaffolding, and inside of which they build their

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This ant builds its nest in the trunks of dead trees, or in the dead wood of living trees. The nest is a maze of branching and anastomosing excavations, consisting of more or less spacious chambers connected with one another by tubular tunnels or galleries. These galleries often continue down into the soil, especially in arid regions where the wood dries out during the summer. The chambers serve as nurseries for the brood and also for the assemblage of ants. A mature nest may contain over 2,000 individuals.

The workers are of several sizes: *(a)* large forms, resembling the queen and endowed with large heads and formidable mandibles, called major workers or soldiers; *(b)* smaller and more slender forms, with smaller heads, known as minor workers; and *(c)* very small forms, known as minim workers.

The observation nests were of several kinds: *(a)* closed nests, consisting of a wooden frame between two plates of glass, one plate forming the floor of the nest and the other the roof. The enclosed space was divided into several communicating chambers by wood partitions. A black cloth placed on the roof kept the nest in darkness. A much smaller nest, communicating with the large nest, served as a feed box; it was always kept uncovered; *(b)* open nests, identical with the closed nests, except that the nests were placed on a platform of wood, 14" x 18" in size. The platform was either supported on stilts over a pan of water somewhat larger than the platform, or it was surrounded by a tin trough about one inch wide filled with water, which formed a moat around the platform. The nest was provided with one or more exits which allowed the ants to come out and wander about the platform. The so-called bulldog ants are fond of water, even bathing in it; but most ants, Camponotus included, avoid water, though individuals will at times blunder into it, and in their struggles reach the opposite shore and escape.

When the colony is brought in from the field and placed on the platform, there is great confusion and much running about. Many tumble into the water, the momentum of their headlong pace making it impossible for them to stop in time. But very shortly some of them find the dark security of the nest. Apparently the news of the find is passed around, and more and more individuals enter the nest. But the process is too slow to suit some individuals and soon, all over the platform, you find these individuals pulling their sisters by the mandibles towards the nest entrance. The sight is particularly amusing when a minim worker, hardly one-quarter of an inch long and one-sixteenth of an inch wide, is pulling a queen fully an inch long with an abdomen three-sixteenths of an inch wide.

The same thing happens in nature when a colony is moving to a new nest and some of the members decide that the old nest is good enough for them and they insist on staying there. They are dragged and often literally carried to the new nest. Toward nightfall the returning foragers are often seen carrying one of their own, probably a worker too weary to come home under his own power. The carrier ant seizes the ant to be carried by the mandibles and holds her with back directed forward and downward and head uppermost, while the one being carried curls up her body and draws up her legs.

THE ROUTINE WORK OF AN ANT COLONY

The activities of a colony are many, among them being the guarding of the nest, the excavating or construction of galleries and chambers in the necessary enlargement of the nest, the foraging for food and the bringing home of the booty, the care of the brood, and the removal of the refuse of the colony to an obscure corner of the nest or to the exterior.

Whether all ants engage in all these occupations, or whether certain tasks are the duties of certain individuals, is a disputed question. Lubbock is of the opinion that the first occupation an ant engages in

after emerging from her pupal shell will be her specialty during life. Wheeler seems to hold that the first task of the callows is nursing, and that they do not engage in any other occupations until their armor has hardened sufficiently to protect them.

A certain distribution of labor is, however, evident. In the observation nests the care of the brood, the enlarging and cleaning of the nest, and most of the feeding were taken over by the minor and minim workers; the guarding of the nest and the fighting were done by the soldiers.

HABITS OF CLEANLINESS

I placed a wad of cotton, soaked in benzene, in a closed nest containing soil. The ants became frantic; some of them pulled off bits of the cotton and tried to carry it out of the nest; others brought particles of soil and piled them around the cotton, until the fumes drove them off.

I squirted a pool of water in front of the exit of the nest, thus preventing the ants from leaving the nest. Again much excitement, but soon the water disappeared under a heap of soil particles, and the way out was clear.

A colony of ants was placed in a closed nest with considerable soil and debris. The soil and debris were removed to the feed box. After a week, the nest was placed on a platform surrounded by a water moat. The ants brought out the soil and refuse from the feed box and scattered it indiscriminately on the platform. About an hour later, a single individual began to pick up the debris and carry it to the edge of the platform. There, leaning out as far as possible, she dropped the particles into the water. Others soon imitated her example. At first they dropped their burden into the water at any point, wherever they reached the edge of the platform. The next time I observed the colony, the ants were all dropping the particles into the water at the same point, and they had all but completed a bridge of soil across the width of the water moat.

The above observations indicate that any foreign matter found in the nest, particularly if noxious, is removed from the nest, or, if that is impossible, is buried; that anything objectionable placed in their path is likewise buried; that the refuse of the nest is deposited at a definite place, either within the nest or above ground. Such accumulations are known as kitchen middens. Was the filling of the water moat with soil particles an intelligent attempt at bridge building? No, just the kitchen midden habit.

CO-OPERATION

On several occasions I noticed the ants working in pairs, one bringing the nest refuse to the exit and dropping it on the platform, whilst another picked it up from there, carried it to the edge of the platform and dropped it into the water.

A small potted locust tree was placed on the platform. Later I discovered the ants digging furiously in the soil, apparently intending to establish their home there. The excavators carried the soil to the edge of the pot and dropped it down onto the platform. Another crew, down below, picked it up and carried it to the water.

FORAGING

Camponotus pennsylvanicus is omnivorous, and I fed her on honey, bits of dates, figs, cake, flesh and insects. In the observation nests only 5 or 6 ants a day, usually minor and minim workers, patronized the feeding dish, though the colonies contained as many as 200 individuals. The feeders would return home and feed the hungry members by regurgitation. One minim worker, recognizable by a slightly defective antenna, was observed feeding daily for two weeks, which would indicate that the same individuals do the feeding each day. But I had trained her to accept honey from the tip of my finger, which may account for her daily foraging. I am inclined to believe that the members of the colony forage at any time hunger moves them.

Whenever I disturbed the privacy of the nest by lifting the black cloth that covered the nest, I observed from 5 to 20 ants, mostly soldiers, standing in a semicircle facing the entrance of the nest, and quite separated from the main body of the colony. At the sudden admission of light they would open their mandibles, and move about uneasily. Some of them would retreat to the main body. For a time I considered the semicircle of ants a guard-line, ready to attack any invader of the nest.

One day I raised the cloth just as a forager entered the nest. On the instant the semicircle of supposed guards closed in on her, begging with antennae for food. The forager obligingly regurgitated drop after drop to the beggars. The guard-line had turned out to be a bread-line, though it is quite likely that it also functions as a guard-line.

CARE OF THE YOUNG

The ants attend to their young from the time the egg is laid until the fully formed adult emerges from the cocoon. The brood is segregated, the eggs, larvae and cocoons being placed in separate piles, either in the same or in different chambers; the larvae and pupae are again sorted into several piles according to size.

In general, the smaller the worker, the more it confines its work to the care of the brood. The nurses frequently lick the eggs, and it is possible that some of the saliva is absorbed. At any rate the saliva causes the eggs to adhere to one another, which allows them to be transported in packets when danger threatens. It may also have some antiseptic qualities that prevent the growth of molds.

The larvae of the Carpenter ants are fed by regurgitation and are kept scrupulously clean. In order to spin the cocoons, the larvae must be surrounded with particulate matter, between which they can suspend the scaffolding, and inside of which they build their

cylindrical cocoons. In my observation nests, bits of refuse were placed about the larvae and, in some instances, smaller larvae were apparently used to anchor the scaffolding. When completed, the cocoons are cleaned and stored together. As the time for emergence approaches, the nurses cut a slit in the head-end of the cocoon and assist the youngsters in escaping.

GUARDING THE NEST

Originally, this open nest had but one entrance. Later on I added a second, smaller one; in time the ants succeeded in cutting two more through the wooden walls. Observations made at all hours of the day and night almost invariably revealed one or two soldiers crouching close to the platform near the original main entrance, perfectly motionless, as though in wait for game. At intervals the guard would walk over to the other entrances and look around, or even look in. Then would follow a survey of the top of the nest and, this completed, the guard would walk back to her original post, look in the entrance to see whether all was still in order, and possibly, too, to pass along an "all's well."

The food dish, containing honey and other sweets, was often visited by flies, which would make madam Ant frantic. She would lunge at the fly, missing her of course, and perhaps more angered, would run around wildly in circles. When several ants were feeding, usually only one of them took it upon herself to drive off the flies. Whether she was stationed there for that purpose, I do not know.

DEFENDING THE NEST

Repeatedly strange ants of the same species as that of my colony and of other species were placed on the platform. If a soldier met the stranger she immediately went into battle; a minor worker might give battle, but as often might rush back to the nest; a minim worker seldom waited on ceremony, but hurried pell mell for the nest. That these home-rushing individuals spread an alarm was evident from the fact that they had no sooner entered the nest than several soldiers rushed out with mandibles agape and antennae waving, looking for the intruder. Repeated calls for help may be given and responded to. Thus, one of the major workers engaging in single combat was gradually reinforced by 13 of her sisters, brought out by minim workers carrying the news of the battle to the colony.

When two strange ants meet they may tangle immediately. But if they are equally matched, and probably, experienced, they may face one another and spar for a hold. At the same time they may curve the tip of the abdomen forward, and directing it at the enemy, squirt acid at one another. The acid may miss its goal, and, tired of parleying, they rush at one another and try to lay hold with their mandibles on some joint of the body or of the legs where the skin is thin and unprotected by chitin, and, therefore, can be cut more readily. Once they have pierced the skin, they bring up the tip of the abdomen and inject acid into the wound, which will paralyze and kill the adversary. Even the uncut skin, if exposed and stretched by pulling, will absorb acid. If enough is absorbed, the result will be death.

The fierceness of the battles can be judged by the fact that almost invariably one of the combatants is killed. Sometimes both die. The survivor is often maimed considerably. One soldier, in a single battle, lost an entire leg and half of another, and a part of an antenna; ever after she walked with a decided limp. She had, moreover, lost all taste for further combat, for, provoke her as I would, she would never strike back, but always retreated to the nest, thinking, probably, that prudence was the better part of valor.

Once an ant gets a good grip she is loath to let go. An ant may kill her antagonist, but if the antagonist has managed to get a grip on her, the killing may not be the end of her troubles. The mandibles of the dead victim may not relax; they may grip all the more tightly. The victor tries to free herself, her friends try to help her; but she cannot shake the dead load. The best she can do is decapitate the victim and thus lighten the burden she must bear for a time. That is why, after a battle, it is not unusual to see the victor walking about with the head of her victim dangling from a leg or an antenna; head huntress, but not by choice.

LEISURE ACTIVITIES

Ants not engaged in any of the necessary activities of the community, spend their leisure time in cleaning the surface of their own bodies and those of their comrades with their tongues and strigils. This removes all particles of soil, and coats their armor with an oily film which probably protects them from moisture and prevents the growth of molds and bacteria.

I once interpreted a scene I witnessed, as two ants caressing and attempting to feed a dead ant lying on her back. An hour later no dead ant was to be found anywhere. Similar experiences and further observation revealed that the recumbent ant was not dead but was revelling in a thorough cleaning and massage.

ESTABLISHMENT OF NEW COLONIES

In early Spring on a certain day, or even at the same hour, the workers of all the colonies of Componotus pennsylvanicus in the neighborhood, urged probably by meterological conditions, bring their winged forms out of the nest for the nuptial flight. After preening their wings and tuning up their muscles, the male and females, one by one, or in small groups, take to the air. Here the members of the different colonies of the neighborhood become intermingled, and undoubtedly a good deal of cross-breeding takes place. The couples then descend to earth and, unlike the bees, separate without the female tearing away the male genitalia.

The female then divests herself of her wings by pulling or rubbing them off against pebbles or soil. She seeks some secluded cavity, preferably under the bark of dead trees, where she walls herself in. She

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The Semi-Micro Method Applied to a High School Experiment

• By Sister M. Lawrence, R.S.M., M.S., *(Catholic University)*
MOUNT MERCY ACADEMY

and William J. Schiller, Ph.D., *(University of Pittsburgh)*
MOUNT MERCY COLLEGE, PITTSBURGH

Much interest in semi-micro chemical methods was aroused by the articles written by Sister Lawrence and Doctor Schiller, which appeared in our issues of September, 1936 and June, 1937.

Many teachers have asked for more definite information concerning procedures. This article, by showing how a single experiment is developed, will answer some of the more common queries.

The laboratory manual mentioned may be obtained by writing the authors at Mt. Mercy College. The cost is 85 cents.

We have already published two articles in THE SCIENCE COUNSELOR on the semi-micro method as applied to high school chemistry. These articles gave a general idea of the apparatus, the methods, and the expense involved in carrying out laboratory procedures by this new technique.* It sometimes happens that such general considerations do not give a precise idea of all that is involved. At the time our previous articles were published, suitable photographs of the equipment required were not available. Consequently, the reader had to build up a picture from the descriptions. We hope that the present article will clear up certain vague conceptions as to semi-micro procedure.

The experiment that is described here is taken from the authors' *A Laboratory Manual for High School Chemistry*. Readers will note that the methods used in this experiment are adaptations of the regular large scale procedures, but reduced to a much smaller scale.

As we have stated in our other articles, the teacher contemplating the adoption of semi-micro methods should feel no insecurity in using the new methods since the only vital change is a reduction in the scale of operation.

Special attention should be given to the method of questioning. Numbers as they appear in the description of the experiment draw the students' attention to vital points of observation, or to theoretical principles.

*A catalog showing the prices of apparatus and the complete cost of equipping a semi-micro laboratory may be obtained by writing the W. M. Welch Co., 1515 Sedgwick St., Chicago, Ill.

Fig. 1. **PREPARATION OF OXYGEN.**
Note Size of Receiver.

PREPARATION OF OXYGEN — ITS PHYSICAL AND CHEMICAL PROPERTIES

I. Preparation.

A. *From Oxides and Peroxides.*

1. Fill a 2 cc. test tube to a depth of about one-fourth of an inch with mercuric oxide. Spread it along the side of the tube and heat strongly. Hold a glowing splint at the mouth of the test tube. When the oxygen begins to be liberated the splint will glow brighter and perhaps burst into flame. (1)

   Mercuric oxide → Mercury + Oxygen
   Heated

2. Place sodium peroxide in a 2 cc. test tube to a depth of about one-fourth of an inch. Add a few drops of water. Quickly hold a glowing splint to the mouth of the test tube. (2)

B. *From Chlorates.*

1. Mix one gram of potassium chlorate and 0.5 gram of manganese dioxide on a watch glass or in a crucible. Transfer the mixture to a four-inch test tube fitted with a No. 00 one-hole rubber stopper and delivery tube leading to a pan or an evaporating dish three-fourths filled with water. Fill five 8 cc. vials to the *brim* with water and have at hand corks to fit.

   Picture of Apparatus. Fig. 1.

   Now, holding the burner in the hand, heat the mixture gently with a small flame keeping the burner in constant motion. (*Caution:* Do not hold the hand

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Fig. 2 **REAGENT BLOCK AND STUDENT KIT.**
Materials and Apparatus for a Full Year of Laboratory Work.

Motivation in Science

• By Howard J. Leahy, A.M., *(Tufts College)*
SCHOOL OF EDUCATION, DUQUESNE UNIVERSITY.

Teachers in schools of education do not always express their views as frankly, forcefully, and clearly as does Mr. Leahy in this article.

You may not agree with him. Some of his statements may provoke you a bit. But it is possible that you will find things said in this article that you have often wanted to say.

Why not discuss this paper at your next faculty meeting?

●

For several years I taught science in several public secondary schools in New England. The teaching of general science, biology, chemistry, and physics was part of my daily tasks. I have spent sufficient time with my students in science laboratories so that I have clear images of what a test tube looks like; of how a microscope works; of the difference between a micrometer and a vernier caliper. In other words, I feel sure that I have been as scientifically minded as any average high school science teacher. I know the names of hundreds of pieces of scientific apparatus ordinarily found in the laboratory. But I am not certain that I could manipulate correctly every piece of equipment in your individual laboratories or those of any other science teacher, since almost everyone who teaches science has a few pet gadgets known only to himself, and from which he derives the greatest amount of satisfaction by merely handling them or even gazing at them, if he cannot find the time to learn the secrets of their operation.

I have used some of the texts supplied by publishers for our profession; but again, I cannot be sure that I am acquainted with the particular books that each individual teacher has used, or is now using, inasmuch as the titles, revisions, and contents change from year to year, and unfortunately, my employers would never permit me to partake of the latest style among science texts. I have had the experience, too, of listening attentively to this speech and that oration delivered by well-meaning persons, such as myself, who pose as experts. So at this point let me caution you to weigh carefully, as you would a particle of matter on the analytical balance, each statement that I make. Accept only those suggestions that have the characteristics of sound common sense.

Let me state emphatically that what I have to say does not represent the doctrine of any particular educational or psychological cult. Propaganda has no place in the field of teaching. Its use has already befogged some of the pertinent issues. Instead of getting nearer to the solution of how to motivate the learner, we have somewhat confused him.

The other day I happened to pick up a book that dealt with the principles of teaching as practiced a quarter of a century ago, and I was amused to observe that some of the problems of pedagogy that remain unsolved today were perplexing the minds of teachers twenty-five years ago. This observation did one thing for me. It impressed me with the necessity of bringing some of the perennial problems to a satisfactory solution soon, if education is to justify its position as a leading agency in the preparation of young people for worth while, purposeful existence.

Among the numerous questions that appeared to bother pedagogs then, the problem of how to motivate the child so that he would be prompted to utilize all his innate and acquired energies in making satisfactory adjustments to life situations occupied a prominent place in the minds of educational thinkers. If the emphasis placed upon motivation in educational literature at present can be taken as a reliable measure of importance, we may safely conclude that teachers are intimately concerned about how to motivate the learner at various stages of his development. But, all do not agree as to just what should be done, or the manner in which motivation should take place in any particular classroom.

From the practical point of view, a motive is an inner impulse that prompts a learner to apply his inherited capacities, his innate energies, and his acquired skills to the satisfactory adjustment of his whole organism to a life problem that demands solution. In a recent magazine article, Dr. Robert Maynard Hutchins implied the need for motives in learning situations when he said "the only education which is any good is that which the student acquires under his own steam, the function of the teacher being to get up the steam as well as provide guidance—to arouse the student's interest and at the same time avoid being a drillmaster or a nurse."[1]

It is the function of the teacher to provide the techniques, the methods, and the principles that will set up within the learner's mental mechanism, the most wholesome drives toward worthy accomplishment in a specific field of inquiry. In science teaching, before we can suggest the exact nature of the subject matter to be taught or the methodology to be used, we must formulate clearly in our minds a series of objectives designed to lead to certain specific outcomes.

We should not strive primarily in our high school science courses to prepare highly skilled technicians for industrial pursuits, but we ought to try to give as many students as possible some understanding of the scientific method of approach to the solution of problems of intimate concern to youths living today. In some situations we shall discover that they may best

be familiarized with the methods of science through adequate supervision and guidance in the application of laboratory procedures to the study of certain definite scientific phenomena. This recommendation proposes to emphasize the need of laboratory instruction of a type where individuals will meet novel and dynamic problems with sufficiently interesting features to attract their wholehearted interest and attention. Then, there will arise in their intellects incentives that will lead to systematic thinking and productive accomplishment. As the Very Reverend J. J. Callahan so ably states, "Man has a natural curiosity that urges him to replace his ignorance by knowledge, and if this natural desire is not stunted and impaired, it acts as the necessary stimulus to drive the will in the pursuit of learning. Show the child some purpose that seems worth while to him, and some intelligent method of attaining it, and you shall find a real lively response through his will to learn . . . It is this natural curiosity that the teacher must use to transform the innate powers into expert powers capable of organizing knowledge and discovering truth. This means discipline and the power of self direction."[2]

Unfortunately, many of the laboratory manuals and workbooks utilized now in our secondary school science classes do not set up stimulating, worthy motives but prompt the student to act more like a machine than a thinker. Numerous blank spaces and incomplete sentences constructed by so-called textbook experts tend to stimulate haphazard guessing rather than logical thinking on the part of the learner. It is good mental hygiene to require an experimenter to summarize the procedures followed, the results obtained, and the conclusions drawn, after participation in mental activity. Reflective thinking is demanded, and this mental exercise will aid the deductive faculties of the mind in the formation of meaningful scientific generalizations.

Among the loose thinkers of our modern age the distinction between the correct and the incorrect is not always clear and certain. Modern man is pitifully enslaved to advertisement and to propaganda. Through the press, the motion picture, and the radio our people are bombarded by an imposing array of questionable claims for a wide variety of manufactured commodities. In the proper study of science a person can acquire an understanding of the value of truth. To counteract the false implications involved, science instructors should communicate to youth the ways in which the scientist works. He has one outstanding impulse, to find out the truth. In striving for that goal he will sacrifice his own comfort, compensation, and leisure, as well as that of his own family and friends.

His preliminary observations and tests are merely the bases of a series of elaborate experiments designed to prove or to disprove the validity of his preliminary assumptions. If in the course of events there comes forth a new phenomenon that cannot be reconciled with his theories, he does not try to suppress it. He may even continue in his patient studies—to the point of repeating his procedures one hundred or more times—before he becomes satisfied. He is always aware that new facts may turn up to contradict his own conclusion. This premonition, however, does not curb his inquisitiveness and persistence, for he will set out to seek the facts that may disprove his own discovery. His entire life is characterized by an unending quest for the truth.

In science education below the college we are not interested in producing specialists. If we could only instill teachers with this noble idea, no longer would our laboratories and classrooms be places where the thrill of problem solving is buried in a maze of directions suggesting the putting together of certain materials to obtain definite reactions. Witness the sloppy techniques and manipulative procedures demonstrated by pupils who obediently go through the artificial motions of scientific experimentation. Teachers do not understand the meaning of motivation. Hence, it is easy to observe in the ordinary high school laboratory youngsters engaged in throwing mixtures and solutions together with little comprehension of what they are actually doing. They give the impression of running a wild race to see who can complete the largest number of experiments in the shortest space of time. The search for truth is practically non-existent in their mental imagery. The emphasis is placed upon the fulfillment of a curriculum requirement that has no sound fundamental reason at its base, other than that the policy has been part of the social heritage of science teachers. No one has ever proved that a science student who performs forty or fifty experiments in the course of a year is better prepared in the use of the scientific method than if he had devoted an equivalent amount of time in the careful, persistent investigation of fewer worth while problems within the capacity of his immature mind.

In trying to adopt techniques and methods that will give rise to better motives among science pupils, a group of educators have suggested the adoption of instructional procedures stressing the concrete and practical qualities of things to be learned. This trend in educational thinking would be very healthy were it not for the fact that many teachers are misconstruing the implications of the method. It is true that verbalism has been used too extensively in teaching the young, for we all know of instances where misconceptions and misunderstandings with respect to the meanings of things have resulted through the employment of verbalistic techniques. But, no real educator believes that any subject can be taught successfully by the utilization of visual aids alone. As an integral part of teaching techniques they are productive of worthy ends.

Nevertheless, here and there we find science instructors who believe, for example, that in biology if we cannot bring the dairy to our school we must move our pupils to the pasteurizing plant.

In chemistry, in order to understand the artificial manufacture of ice, children must be transported in toto to a commercial ice plant. In physics, students

must visit industries to gain an adequate understanding of the intricate mechanisms of machines. These activities are termed school journeys, and it is claimed that they will bring about greater attention, more prolonged interest, and better achievement in the classroom. Experience and observation indicate that school excursions are apt to degenerate into recreational activities wherein pupils perceive many disconnected things, without carrying away any abstract notion with respect to the meanings of the things perceived. This unwholesome condition is disturbing to people who believe that education should try to assist young people to control their thoughts so that they will leave school better able to think logically than when they arrived.

No one questions the worth of the motion picture and other slide projectors in attempting to bring to the student of science happenings occurring at distant points. It is only when these visual aids become a substitute for the pursuit of individually planned science projects requiring the boy or girl to apply his innate capacities and acquired knowledges to the task of solving problems, that justifiable criticism is leveled at them.

In certain educational circles, notably the ranks of the ultra-progressive who really are misinterpreting the goals of progressive teaching, the assignment, the lecture table demonstration, and the individual laboratory experiment have been relegated to the educational garbage pile as procedures that no longer educate the young. I want to go on record as a sincere supporter of the use of the assignment in science teaching. Youngsters below the university level need the guidance of trained teachers who will assign them definite scientific problems for solution. They are not mature enough to know what is good for their intellectual systems.

If it were true that youngsters were capable of choosing the paths which their scientific inquiries ought to follow, we could dispense with schools and teachers tomorrow. The emphasis upon a knowledge of child interests, impulses, and desires in deciding science curricula[2] is outrageously ridiculous, and if this idea is carried much further our taxpayers and parents will rise up with overwhelming indignation and demand that their children be returned to their home shelters until educators really justify the tremendous expenditures wasted annually on a lot of tomfoolery under the guise of education.

Science teachers need to discover through systematic analysis the knowledges, the skills, and the techniques that the majority of our populace ought to know if they are to live happy, productive lives. This information can be secured best by the teachers in service who will take the time to study the individual needs of the families whence their charges come. It cannot be trusted to the Ph. D. candidates who have already filled our college libraries with a conglomerative mass of nothing, bound together in the form of useless theses that are gathering dust and disintegrating as fast as nature will allow their pages to oxidize.

It may appear that I have been unjustly critical of science teaching. Perhaps, to avoid misunderstanding it would be wise to make some suggestions with respect to what the teacher of science ought to do to improve science instruction. All courses in science should contribute to a person's understanding and appreciation of his:

a. Spiritual well-being
b. Physical well-being
c. Cultural well-being

In other words, the applications of science in civic, sociological, and the other aspects of modern life must be an important criterion in the construction of any type of science curriculum. The part which the results of scientific research have played in the development of our present civilization cannot be ignored. Science instruction in the biological, chemical, and physical realms must show the part which these results are capable of playing in developing a much higher type of civilization than we now enjoy, if properly utilized by man.

The activities conducted within the science laboratory and classroom must be merged so that the workroom atitude will prevail. Difficulties and obstacles met during investigations employing laboratory techniques should be discussed when they arise and not at a specific later recitation period. Investigations and oral group discussion must be combined if we are to learn how to solve problems.

Activities that will tend to make the individual:

a. A more careful and analytical solver of the problems that confront the youth today and that will face the adult of to-morrow.

b. A more intelligent interpreter of scientific evidence appearing in his own environment in the light of its present meaning to the individual or to the group, and its possible future use.

c. An active contributor to the growth of his own personal self and the improvement of the selves of his fellow students,

should be utilized as fundamental criteria in any attempt at definite construction of curricula in the physical and biological sciences.

Finally, we ought to remember this most adequate definition of education by President Callahan, "Education is primarily discipline—discipline in the logical order of proceeding; discipline in keeping the mind steady and persevering in the path of correct method. It means, therefore, power over our powers of thought, and direction of our intellectual activities as they move toward a perceived and desired end."[2]

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Photochemistry

• By H. Austin Taylor, Ph.D., *(University of Liverpool)*
PROFESSOR OF CHEMISTRY, NEW YORK UNIVERSITY

Photochemistry deals with the chemical reactions that are produced or influenced by visible or ultra-violet light.

From this paper you may learn something about how photochemical processes are interpreted. Do you know why rock salt becomes visibly colored when irradiated by ultra-violet light? What has the quantum theory to do with photochemistry? What are inhibitors and how do they work?

Here is an unusual article that deserves careful study, not casual reading. The author has simplified a difficult subject so successfully that those teachers who know little or nothing of this branch of chemistry will be interested and informed and, we hope, stimulated to further study in this field.

The changes in the incident energy that occur when light strikes any body may be numerous. Usually a certain amount of the light is reflected, a certain amount is absorbed and some may be transmitted. Photochemistry is concerned mainly with the chemical changes that may be brought about by the absorbed radiation. Theoretically the effects of any type of radiation, from the "hardest" x-rays at one extreme to radio waves at the other, should be included in the science. Practically, however, photochemistry has been restricted to the effects produced by visible and ultraviolet light, and its extension to other wavelengths is still in its infancy.

The satisfactory interpretation of photochemical processes is due in large measure to the development of the quantum theory as applied to both matter and radiation. According to this theory, radiation consist of discrete bundles or quanta of energy, the magnitude of a quantum being directly proportional to the frequency of the light. Einstein postulated that the occurrence of a photochemical reaction is the result of an absorption by an atom or molecule of one quantum of energy. It would thus seem at first sight that the ratio of the number of molecules reacting to the number of quanta of light absorbed—the so-called quantum efficiency—should always be one. Observation shows, however, that this ratio may vary from values less than unity to more than a million. This apparent inconsistency is due to the complexity of the actual processes which occur in the overall reaction. Thus, the primary process initiated by the quantum absorption may be succeeded by secondary processes, themselves independent of the action of light. These latter may be so considerable as to mask completely the change involved in the primary photochemical act. The Einstein postulate is applicable to the primary process alone. A knowledge of the state of the molecule as a result of the primary absorption may frequently suggest what secondary processes are possible. This is one of the reasons that the study of photochemistry is so useful in the more general study of chemical kinetics.

The primary absorption process is thus the most important one, and it is the spectroscopist that has outlined its various possibilities. If the absorbing system contains only atoms, these when not illuminated are normally in their lowest energy states and upon absorption of light pass to some higher energy state becoming thereby excited atoms. If left to themselves these excited atoms will revert to their normal state emitting the absorbed energy as fluorescence radiation. However, if the excited atom should collide with some other atom or molecule, its excess energy may be transferred during the collision. Thus Cario and Franck showed the presence of excited thallium atoms in a mixture of mercury and thallium vapors which was illuminated by radiation absorbed only by mercury. Or again, they showed the presence of hydrogen atoms in a mixture of molecular hydrogen and mercury when similarly illuminated. This transfer of energy is known as photosensitization; the use of dyes to render a photographic emulsion sensitive to colors to which it does not normally respond is an important application.

If the amount of energy absorbed by an atom is sufficiently great, ionization may ensue, that is, an electron is ejected leaving a positively charged ion. This is a definite quantum phenomenon, a quantum of minimum frequency being necessary to accomplish it. If the frequency used is less than the minimum required, ionization will not occur, while, if a larger quantum is used, the excess energy over that required for ionization is dissipated as kinetic energy of the ion and electron; they will fly apart the faster, the more the excess energy available.

The absorption of light by molecules is more complex than that by atoms. In atoms, energy can be absorbed only as potential energy of attraction by the positively charged nucleus for the electrons; in molecules, there are the additional possibilities of increases in the energy of rotation and vibration of the atoms in the molecule. These latter energy increases are also in general quantized, that is, they may increase only by definite discrete amounts. Evidently there is consequently an enormously larger number of excited states for a molecule than for an atom. An immediate result of this is the possibility of a molecule possessing considerably more energy than is actually necessary to dissociate it, without dissociation occurring. This is because energy is partly electronic, partly vibrational and partly rotational, while for dissociation to occur a definite minimum vibrational energy is required.

Such excited molecules will, however, usually dissociate on collision since during collision a redistribution of the available energy occurs and the minimum vibrational requirement is satisfied.

Such dissociation of molecules into fragments by the two stage process of absorption of light followed by collision with some other molecule can obviously also be achieved as a direct result of absorption of a sufficiently large quantum, in a manner analogous to the ionization of an atom.

There exists a third possibility leading to dissociation which is rapidly becoming important photochemically. As has been pointed out a given amount of energy of excitation may be distributed in a molecule in various ways, as electronic, vibrational or rotational energy. In one state the molecule may absorb from a given quantum, for example, more vibrational energy and less electronic and rotational energy than for some other state. Assume that a molecule is brought into a higher electronic and vibrational state by absorption of an amount of energy which, in its lowest electronic state would have brought about dissociation; these two states are in a sense sympathetic with each other, or as is said, are in resonance. The molecule may then pass spontaneously from the higher to the lower electronic state with ensuing dissociation. The more complex the molecule the greater becomes the possibility of such resonance and hence also of dissociation. This phenomenon is referred to as predissociation. It involves the three stages of absorption, resonance and dissociation and may be independent of any collisional process.

The foregoing discussion has been based essentially on the behavior of gases. With liquids and solids the problem is usually still more complex owing to the proximity of the molecules. Nor are observations so easily interpreted as with gases. To consider but one complication, when in gases a molecule absorbs sufficient energy to dissociate it under the proper conditions as previously specified, dissociation almost always results and the fragments may in general be detected. In condensed phases, however, the chance of immediate recombination of the fragments is so great that the actual efficiency of the primary absorption process may be almost vanishingly small. The present knowledge, therefore, of reactions in these condensed phases is considerably behind that in gases. This is easily seen when the problem of photosynthesis (the conversion of carbon dioxide and water into plant carbohydrates) or the problem of photography involving the light sensitivity of silver compounds is considered.

A start however, has been made in certain simple cases of solids where the forces operating in the crystal lattice are sufficient to prevent immediate recombination of dissociation products. Thus rock salt when irradiated by ultra-violet becomes visibly colored, a typical photochemical reaction even if a simple one. By measuring the intensity of color and comparing this with the light absorbed, the quantum efficiency has been shown to be unity under certain conditions. The primary act is presumed to be a liberation of an electron from the chlorine, which electron then locates itself in a "hole" in the lattice, that is, a position in the lattice not already occupied by either sodium or chlorine. This electron may now vibrate in the field of its six surrounding neighbors absorbing or emitting energy in the visible region; hence, the color observed. Here, then, is an almost unique simple photochemical reaction in which the primary process is the whole process and the equivalence relationship of one electron for one quantum is realized.

In general, however, the secondary processes which may succeed the primary act are the ones which will control the overall efficiency. To illustrate this, two examples will be considered: (a) the decomposition of hydrogen iodide, and (b) the combination of hydrogen and chlorine. In each case the primary act is the same, resulting in a dissociation of a molecule. The succeeding processes are widely different.

Hydrogen iodide upon absorption of light is dissociated into an atom of hydrogen and an atom of iodine. The hydrogen atom is capable of reacting with hydrogen iodide to produce molecular hydrogen and an iodine atom. Finally, iodine atoms recombine to give molecular iodine. The total process may be written thus:

$$HI + \text{light} \rightarrow H + I \quad \text{(Primary)}$$
$$H + HI \rightarrow H_2 + I \quad \text{(Secondary)}$$
$$I + I \rightarrow I_2 \quad \text{(Secondary)}$$

The absorption of one quantum of energy by a hydrogen iodide molecule thus not only dissociates that molecule but produces at the same time a means (namely, the hydrogen atom) of dissociating a second molecule. Measurement shows, then, that two molecules are decomposed for each quantum absorbed. The quantum efficiency is two.

In the hydrogen and chlorine combination the light used is absorbed solely by the chlorine molecules dissociating them into atoms, thus:

$$Cl_2 + \text{light} \rightarrow 2\ Cl$$

Two secondary reactions are now possible:

$$Cl + H_2 \rightarrow HCl + H$$
$$H + Cl_2 \rightarrow HCl + Cl,$$

a chlorine atom reacting with hydrogen to produce hydrogen chloride, liberating a hydrogen atom, which in turn can react with chlorine molecules to produce again a chlorine atom. It would seem, then, that one might expect a long chain of secondary processes succeeding the primary absorption. In fact, could these chains not be broken it would only be necessary to introduce one chlorine atom into a mixture of hydrogen chloride. Actual measurement shows that as many as a million molecules of hydrogen chloride are produced for each quantum of light absorbed. This means that not every atom, whether of hydrogen or chlorine, produces one of the other kind but that occasionally some are removed from the system without reacting as above. This is possible by such reactions as:

$$H + H \rightarrow H_2$$
$$Cl + Cl \rightarrow Cl_2.$$

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Educational Usefulness of Science

● **By James N. Rule, LL.D., Litt.D., Sc.D.,** *(Washington and Jefferson)*
FORMERLY PRINCIPAL, LANGLEY HIGH SCHOOL, PITTSBURGH, PA.
SOMETIME STATE SUPERINTENDENT OF PUBLIC INSTRUCTION

One of Dr. Rule's last public appearances before his untimely death was at the latest Duquesne University Conference for teachers of science, where he read this paper which so well expressed his philosophy of education.

Dr. Rule will long be remembered as an outstanding educator. Well versed in science, he was instrumental in the careful revising of science curricula for high schools during his term of office as State Superintendent of Public Instruction.

The final significant sentence of this article could not be better stated: "Science instruction should bring youth closer to God through an understanding of nature's beauties and harmonies and immutable laws, for before all else youth needs God."

●

I. SCIENCE AND EVERY DAY LIFE

Demands of Pioneer Life Upon Education

Pioneer life in America made few demands upon education. E. P. Cubberley in his *Education in the United States* (page 76) speaks of this period as follows:

> "There were but six cities of 8,000 inhabitants or over in the country as late as 1810, and even in these life was far simpler than in a small Western village today. There was little need for book learning among the masses of the people of that day to enable them to transact the ordinary business of life. A person who could read and write and cipher in that time was an educated man, while the absence of these arts was not by any means a matter of reproach."

Rapid Remaking of Every Day Life

One of the most obvious and significant facts, however, that confronts even the casual observer today is the radical remaking of every-day life that has taken place in the last hundred years — yes, even the last twenty-five years—due to the discoveries and inventions of science.

Edwin E. Slosson in a series of remarkable articles appearing some thirteen years ago in the "World's Work" on "Science Remaking the World," indicated with prophetic vision how a single scientific discovery may influence politics, finance, industry, social customs, personal habits, standards of living, moral ideals, the drift of population, and the balance of power. Speaking of the invention of gasoline Slosson said:

> "Then gasoline, which has given man a higher speed than he ever attained before, must rank among the most beneficial of human inventions.
>
> "Any new scheme of speedier intercommunication tends to expand the boundaries of political divisions. But it does more than that. It weakens the boundaries themselves. Statesmen may cut up continents into countries, but science knows no nationality. Ideas will somehow lead through from one language to another. Print and pictures will penetrate anywhere. The map may be colored like a crazy-quilt but nobody can put up partitions in the ether. The frontier may be lined with soldiers, the radio will overreach them. The three-mile limit of the high seas has ceased to have meaning. The self-propelled projectile, the auto-airplane, carrying death in its bombs, has no limit to its range. No wall, trench or barbed-wire fence can shut out the molecules of poison gas. The airplane soars over custom houses. The submarine dives under blockades. The automobile runs across tariff walls. Science erases the artificial barriers that the politician erects. As the world comes under the sway of science, political divisions will be impossible to maintain. Commerce, the child of science, is doing more to promote the unification of the world than all the politicians. Politics is the art of managing men. It was, therefore, of supreme importance in the days when war and work were done by men. But as war and work come to be done by machinery, the importance of the engineer increases."

Demands of Modern Life Upon Education

Life today, in contrast with the pioneer life of our forefathers, demands much of education. Whereas, in the early days of our national life the educational process was a relatively simple affair owing to the simple kind of life our forefathers lived, now education of every type has necessarily become vastly more complex owing to the more complex character of modern life. Education in an age in which the farmer spends but fifteen minutes raising a bushel of wheat demands much more of our schools than in an age when it took a farmer three hours. So rapidly and radically is modern life being changed and reconstructed that a constant re-evaluation of the subjects of the curriculum is necessary if the teaching process is to maintain contact with life. Surely Science, in a world being remade by Science, has much that is useful to offer in the education of our youth, and should come to occupy an increasingly large place in our educational program.

Popular Lack of Scientific Knowledge

The following are some answers I culled from some state examination papers I had set in general science, turned in by candidates for admission to professional courses in institutions of higher learning, who had not had the advantage of a high school education. The questions are obvious and need not be repeated.

1. "One of the most important of recent scientific discoveries is the use of Xrays in the cure of insanity by locating infected nerves usually under the wisdom teeth."
2. "The Weather Bureau is a station where the different conditions of the weather to be are

collected and distributed to the public's information."

3. "Hybrid is selecting the cross breds of a zebra and a donkey to give it more speed."

These are not by any means typical cases, rather they represent an extreme, but they do indicate the thin ice of accurate knowledge about every-day affairs upon which the average person blithely skates. In a push-button civilization such as the present when a person with the mentality of an eight-year-old can get along comfortably, there is real danger of our allowing too much of our working and thinking to be done for us through the medium of the vast number of mechanical gadgets provided for us by science. The pioneer farmer who took three hours to raise a bushel of wheat undoubtedly got more joy and self-development out of his work than a modern farmer who unthinkingly uses machinery to do the job for him in fifteen minutes. The corrective lies, I presume to say, in a type of science instruction in our schools and colleges, which gives man an intelligent and directive rather than a merely mechanical control of Nature's forces to serve his purposes. No man or woman can be said to be well educated, or indeed can be aught else than a mere cog in the modern machine, who does not have an appreciation of the part science plays in every-day life and some notion, also, of the social and economic principles that underlie its more common applications.

Two Main Theses

And this brings me to the two main theses of this paper, which are that the educational usefulness of science material consists (1) in the vital importance of its content as a part of the equipment of every citizen, and, (2) in the influence of its method upon human progress and welfare.

II. VALUE OF SCIENCE AS CONTENT

Benjamin Franklin's Proposals

Science material, if properly selected and organized is educationally useful to everyone for its informational values. As early as 1749, Benjamin Franklin in his "Proposals for the Education of the Youth of Pennsylvania" recognized the usefulness of science as a necessary part of the education of every citizen. Franklin in this very interesting monograph quotes approvingly from a French contemporary as follows:

> "I say that even Children are capable of Studying Nature, for they have Eyes, and don't want Curiosity; they ask Questions, and Love to be informed: and here we need only awaken and keep up in them the desire of Learning and Knowing, which is natural to all Mankind . . . It is inconceivable, how many things Children are capable of, if all the Opportunities of Instructing them were laid hold of, with which they themselves supply us. A Garden, a Country, a Plantation, are all so many Books which lie open to them; but they must have been taught and accustomed to read in them. Nothing is more common among us than the Use of Bread and Linen. How seldom do Children know how either of them are prepared, through how many Operations and Hands the Corn and Flax must pass, before they are turned into Bread and Linen? The same may be said of Cloth, which bears no resemblance to the Wool whereof it is formed, any more than Paper to the Rags which are picked up in the Streets: And why should not children be instructed in these wonderful works of Nature and Art which they every day make Use of without reflecting upon them?"

This proposal of Franklin's for a practical knowledge on the part of the youth of Pennsylvania of the science implicit in the affairs of daily life, is the forerunner of our modern courses in Nature Study and General Science. Franklin saw clearly that on the side of content no subject had more to contribute to the daily equipment of the citizen than Science. It will be pertinent to our first thesis to set down here the contributions of scientific material to the realization of the cardinal objectives of secondary education.

Science and Health

How to keep oneself physically fit, how to promote and maintain the public health are questions which vitally affect and condition the present and future of every one and must find an effective answer in the science instruction of every high school.

Science and the Fundamental Processes

In the teaching of the fundamental processes, such as reading, writing, arithmetic and elements of oral and written composition, the facts and wonders of science provide inexhaustible and highly motivated material. The fundamental facts and principles of science like those of health affect every one of us, not merely on certain days of the week for restricted periods, but every minute of every day and ought, therefore, to interpenetrate and color the material of instruction in other subjects. The work of science instruction should, therefore, include the effective correlation of the materials of science with the other subjects of the curriculum.

Science and Worthy Home Membership

Science has done much within recent years to make home keeping more efficient and therefore to make home life more comfortable and attractive. The high school teacher of science has no more fruitful field of service than in the extension and application of the principles of science to the activities that center around the life and management of the home. These activities have to do not only with problems of sanitation affecting the health of the members of the family, but also with devices and methods that make for increased efficiency in the management of the home and for higher standards of human life in the families represented in the school's clientele. To make every pupil an increasingly helpful and worthy member of his home is an important and fundamental objective of science instruction.

Science and Vocation

Science courses organized so as to show the practical applications of the principles of physics, chemistry, and biology to commerce and industry provide valuable basic preparation for life work, particularly of pupils whose formal education may not extend beyond the

high school period. Science instruction should cultivate an intelligent appreciation of the indispensable part science plays in the development of the human and material resources of our nation. Heretofore our comparatively small population and our seemingly limitless supplies of raw material have given us a dominant position in the struggle for the world's markets. Now the natural increase of our population and the rapid exhaustion of our vast virgin resources are bringing us speedily into competition on even terms with other nations. Science instruction in the high school can do much to instill into our junior citizens—our prospective voters—an intelligent conception of the degree of our dependence upon scientific procedures and processes for the maintenance of the integrity of our national ideals and standards of labor and commerce.

Science and Citizenship

We call a man a good citizen who shows a disposition to cooperate with his fellow citizens for the welfare of all. The cooperation of such a good citizen, however, becomes of largest value only as he learns *how* to cooperate effectively. Good citizenship, in other words, depends for its effective exercise not only upon good will among the members of a community or commonwealth but also upon what Huxley called "organized good sense," by which he means science. An intelligent appreciation of the procedures and processes of science must obviously be an essential and universal factor in citizenship training, if problems affecting community welfare are to be recognized by citizens as of common interest and receive the prompt and effective solution they severally require.

Science and Worthy Use of Leisure

No more certain means can be found of developing in pupils permanent and profitable sources for a worthy use of leisure than the many pleasurable and useful avocational interests that may be established during school days as a by-product of science instruction. These avocational science interests will find their most effective expression probably in such activities as science clubs, visits to museums and industrial plants, and excursions to near-by places of natural scientific value; and no teacher who appreciates their motivating influence upon the regular classroom science work, may wisely neglect these avocational interests.

III. EDUCATIONAL VALUE OF SCIENCE AS METHOD

Important, however, as science is on the side of content in the equipment of every citizen, it is on the side of method that science makes its greatest contribution to education. As John Dewey has well said, "When our schools become laboratories of knowledge making, not mills fitted out with information hoppers, there will no longer be need to discuss the place of science in education."

This is not to minimize the value of well selected content based upon the needs of every citizen. Some pupils can probably get little else out of their science course other than a modicum of useful information, and the needs of such pupils should be met on the side of informational and applied science related to the demands of daily living.

Science as Method

In science as method, there is implicit, however, the accurate observation and classification of data, the formulation of reasonable generalizations to explain the known facts in a selected field, and the verification of generalizations by the testing of predictions, by carefully controlled experiments and the evaluation of additional data.

Scientific Method and Daily Living

The *educational* usefulness of science as method consists in the value of the scientific method as applied to the solution of problems of every-day thinking and living, and in its effect upon the development of ethical character. This point of view regarding the educational usefulness of science as methoa emphasizes the value, in science instruction, of problem solving. The over-emphasis upon science as content has led to an over-emphasis upon lectures and formal laboratory exercises.

Science Instruction and Problem Solving

Science has suffered as much as the classical languages from the delusions of formal discipline. We have been prone to believe, for example, that if a pupil could glibly recite the Mendelian laws of heredity, he would be able to think straight on social questions affecting race improvement. The fundamental fallacy lies in the failure to recognize the necessity of the accurate collection and classification and interpretation of facts, without which straight thinking is impossible. Problem solving provides the opportunity and the incentive for the accurate ascertainment and evaluation of the facts necessary to a solution; and if the problems are chosen from the field of the pupils' present and probable life concerns, then the scientific method becomes increasingly operative as a factor in the daily thinking and living of the individual. Instead of the lecture and of set laboratory exercises alone, a procedure is used in which discussions, reports, demonstrations, experiments, and laboratory exercises are all closely correlated and constitute a unified method of finding solutions to worthwhile problems. Such a procedure, moreover, sets up the same conditions of learning that continue throughout adult life—self-education through purposeful activity.

The traditional organization of the sciences has permitted little flexibility for the adaptation of subject matter to meet the varying capacities and interests of adolescent girls and boys. Such an organization is based on the theory that high school science is *merely* preparatory to more advanced study of science and should, therefore, deal with the fundamentals of the systematic organization of each science. Science material to be educationally useful to the large majority of pupils should be largely drawn from the activities

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Three Opportunities . . .

A Conference for Teachers
A National Essay Contest
A Project Material Display

Science Conference

Teachers of science everywhere are invited to attend the seventh annual Duquesne University Conference for teachers of science in Catholic high schools, which will convene in Pittsburgh on Saturday, February 25, 1939. Each year these one-day conferences have grown in interest and importance. Gradually their area of influence has extended. Teachers representing schools from New York to Chicago now take part. All who are interested in science teaching are welcome. Individual invitations are not issued. *This is your official invitation.*

The Duquesne Conferences are under the patronage of the Most Reverend Hugh C. Boyle, Bishop of Pittsburgh. Each year he graciously addresses the teachers, and views the science project materials submitted for display by many Catholic high schools. Reverend Paul E. Campbell, Superintendent of Parish Schools, and the Very Reverend J. J. Callahan, C.S.Sp., welcome those who attend. This year, addresses will be made by Dr. C. G. King, of the University of Pittsburgh, discoverer of Vitamin C, Reverend Edward J. Wenstrup, O.S.B., of St. Vincent College, experimental biologist, and other noted speakers. There will be demonstrations in physics, chemistry and biology, roundtable conferences, and exhibitions of textbooks, apparatus, and student projects in science. Those in attendance will be the guests of the University at lunch. Tea will be served during the social hour which concludes the program for the day.

There is no registration fee or charge of any kind in connection with the Conference.

The Sisters Alumnae of Duquesne University will act as hostesses during the Conference. They will provide accommodations for all visiting Sisters. When the time of arrival is known in advance, Sisters who come from a distance will be met at trains and conducted to the several convents. Since a large number of visitors will attend, requests for accommodations should be made well in advance through Sister M. Aurelia Arenth, O.S.F., President, Sisters Alumnae Association, St. Wendelin Convent, Custer Avenue, Pittsburgh, Pa.

National Essay Contest

Unusually early announcement of the Duquesne University science essay contest was made in our September issue so that teachers would have plenty of time to arrange for preliminary competitions in their own institutions. A number of schools already have reported their intention to submit an essay. Others who expect to do so will be helpful if they will so advise the Director, by letter or postcard, before the new year.

The subject, "The Microscope and Science," was chosen to enable students of all high school grades to compete. The rules which govern the contest are to be found in our September, 1938, number.

Essays, to be considered, must be sent to the Director of the Science Conference, Duquesne University, Pittsburgh, Pa., so as to arrive not later than February 1, 1939.

Science Projects Wanted

Good instructors in science are always on the alert. They are continually looking for new projects that will enliven their courses and stimulate their pupils. No one teacher has all the good ideas. Everyone may learn. Teachers are aided by studying the projects in successful use by others. It is for this reason that an exhibit of such material is always arranged for the Science Conference.

Duquesne University, therefore, invites teachers everywhere to select some of the more interesting projects they have developed and submit them for display. They need not be original. They need not be elaborate. They need not be expensive. They may be in the form of home-made apparatus, collected materials, specimens, displays, teaching devices, models, photographic work, charts, etc.

Schools are asked to send displays even if no member of the faculty is able to attend the Conference. Last year, exhibits came from as far west as the Rocky Mountains. Regardless of the location of the school, this is an opportunity for its teachers to help other teachers.

Each exhibit should be plainly labeled with the full name of the school, its location, and the names of the teacher and student. They should be well packed, addressed to the Director of the Science Conference, Duquesne University, Pittsburgh, Pa., and shipped so as to arrive on or before February 18, 1939.

All project material will be returned, carriage paid, to the cooperating schools after the Conference.

You Should Read . . .

General Science, Part I

● *By* J. C. PLATT, FREDA JONES, W. C. FRID, and J. H. HOPKINSON, Chadderton Grammar School, Lancaster, England. Chemical Publishing Co. of N. Y., Inc., New York. 1938. viii + 167. Illustrated. $1.50.

This is the first of two volumes dealing with elementary general science, written by the headmaster and science staff of an English grammar school. It attempts to treat science as a connected whole, using biology as the central core of the course and introducing physical and chemical facts as they are needed. Chapter headings include: the flower, germination, root absorption, water, air, combustion, carbon, nutrition, respiration, the butterfly, frog, fly, bee, and the aquarium.

The usual American course in General Science is too frequently almost wholly descriptive, a few demonstrations being given by the teacher. The English prefer that the work shall be largely experimental, to be done by the pupils individually. The experiments outlined in this book are simple. They require only inexpensive apparatus. They are guaranteed to work.

Although this text would not fit easily into our commonly used plan of instruction, it could well be used in conjunction with a good American textbook.

J.F.M.

Elementary Survey of Physics

● *By* ARTHUR E. HAAS, Ph.D., Professor of Physics, University of Notre Dame, and IRA M. FREEMAN, Ph.D., Associate Professor of Physics, Central College, Chicago. E. P. Dutton & Co., Inc., New York. 1938. xi + 203. Illustrated. $1.90.

This book is written with the expressed purpose of presenting a comprehensive, non-mathematical survey of physics for use in college courses in which the purpose is primarily to impart a broad view of the subject. Such recognition of the value of the survey course, both as an introduction for the intended specialist in that field and as a "cultural" course for others, is commendable.

It must be pointed out, however, that limitation of mathematical treatment is not the only requisite in attaining the appeal which such a course must have. The same students who shy away from mathematics also quickly lose interest when the subject matter is difficult to understand. The treatment of at least the key topics therefore should be more elaborate rather than less, so that from these pleasantly surmountable peaks the student may survey with satisfaction and understanding the lesser prominences which complete the picture.

In this respect the present text fails. It is too highly condensed, hence too difficult for the intended use. As specific examples we may mention that inertia and the motions of projectiles are covered by less than a page; that Bernoulli's Principle and Poiseuille's Law are stated and discussed in 15 lines; and that electromagnetic induction, including the quantitative law, Lentz's principle, the method of representing electric fields, and the part played by the law of the conservation of energy, is covered in a page. The treatment of some topics is adequate, however. There are too few illustrations.

The "Supplement for Pre-medical Students," 7 pages, contains too little to be of much value.

On the other hand, the book is authoritative throughout, as we should expect from the authorship. It should be useful as a text for rapid, non-mathematical review or reference.

G.E.D.

Vocational Hygiene, Book I

● *By* DANIEL CAPLIN, Assistant Director of Health Education, New York City, and S. G. OCEAN, Murray Hill High School, New York Globe Book Co., New York. 1938. x + 225. Illustrated. $1.60.

This book studies occupational dangers, vocational health habits, first aid treatment, and the safety measures which should be taken in the shop and on the highway. The sections dealing with the automobile driver's responsibilities are especially valuable. Safety rules for pedestrians are not overlooked. Consideration is given to posture in the sedentary trades and to hygienic conditions in school shops. The illustrations are simple and well chosen. In this book there is considerable information that will be useful to the teacher as well as to the student.

H.C.M.

Physics of Today

● *By* JOHN A. CLARK, Chairman, Standing Committee on Science, Public High Schools, New York City, FREDERICK R. GORTON, Michigan State Normal College, and FRANCIS W. SEARS, Massachusetts Institute of Technology. Houghton, Mifflin Co., Boston. 1938. xv + 632. Illustrated. $1.80.

This high school textbook on general physics ranks high in readability and attractiveness. The emphasis throughout is on interest, and common experiences and observations are used most effectively. The illustrations are numerous and include a considerable number of photographic reproductions. The line drawings are well chosen and well drawn.

Qualitative relations are generally stated without proof, although a type of development involving numerical relations in an illustrative example is used to some extent. The questions at the ends of the chapters are not difficult. The problems, few in number, are very simple. Some are starred for honor work, but these also are simple and easily solved.

Some important topics, as, for example, rotational motion and atomic structure, are unnecessarily and unwisely slighted. Atomic structure is dismissed with a brief 17 lines; while 23 lines and 3 full pages of illustration are given to the topic, "How to fly an airplane." Have we gone so far in our desire to sugarcoat all learning that we confuse the relative importance of two topics such as these?

G.E.D.

The Magic Wand of Science

● *By* EUGENE W. NELSON. E. P. Dutton & Co., Inc., New York. 1938. 213 pp. Illustrated. $2.00.

We like this little book.

Here are described in simple language, intelligible to the high school student and to the layman who has no knowledge of science, some of the advances and discoveries that have been made recently in several scientific fields. Especial attention is given to the commercial applications that have been found for the new information. There are interesting stories about black light, synthetic rubber, chemical farming, plastics, cosmic rays, kitchen chemistry, human electricity, dry ice, soy bean products, noise, and a score of other things.

Although the author writes for young people, adults will enjoy the book and benefit by reading it. Teachers of science will discover, perhaps, that there are developments in their own special fields of which they may not be aware. The brief accounts given in this up-to-date little volume should be enough to stimulate them to further study in a number of directions.

Add this book to your school library. Read it yourself. *H.C.M.*

General Biology Study Book

● *By* HOLGER H. VAN ALLER and DOROTHY VAN ALLER. Saratoga Springs, N. Y., Public High School. Globe Book Co., New York. xi + 181. Illustrated. 1937. $1.00.

The study of biology at the secondary level of instruction must attract the energetic interests of the learner to such an extent that he will be urged to use his own intellectual potentialities in the quest for knowledge about the living things in his surroundings. All techniques, methods, and sensory aids employed by the teacher should accelerate the intellectual momentum of the learner to the point wherein nothing but the true biological facts will satisfy his zeal for knowledge.

Van Aller's Study Book ought to assist materially in achieving the desired end. The science pupil who uses this guide as recommended, will find himself delving into source material in the laboratory, in the library, in the classroom, and in the functioning aspects of his own immediate environment. Thus, biology will become a lively challenge that will drive him on to the achievement of more meaningful interpretations of the phenomena associated with life in the plant, animal, and human realms.

HOWARD J. LEAHY,
Duquesne University.

The Semi-Micro Method Applied to a High School Experiment

Continued from Page One Hundred and Nine

directly under a heated object at any time.) Let the first few bubbles escape. This will rid the generator of air. Now, placing the thumb over the mouth of one of the filled vials, invert it into the pan until the mouth is under the surface of the water and directly over the delivery tube. The bubbles of oxygen will enter the vial and displace the water. Heat so that a steady flow of oxygen results. If the gas is being generated too rapidly withdraw the heat for awhile. As soon as all the water is displaced from the vial quickly stopper it, and collect another vial of the gas. If the gas is being generated fast enough, it will be unnecessary to remove the delivery tube. However, if the water begins to suck back, either apply heat, or remove the delivery tube from the water. Collect five vials of the gas. (3)

Fig. 3. **DISASSEMBLED STUDENT KIT SHOWN IN FIGURE 2.**

II. Properties.

A. *Physical.*

Invert a vial of the gas into a beaker of water. (4)

B. *Chemical.*

Insert a glowing splint into a vial. Observe the results. This is the test for oxygen. (5)

Heat some powdered charcoal on a spatula until it glows and quickly insert this into a vial of oxygen. (6) (7)

Repeat the above using powdered sulfur instead of charcoal. (8) (9)

Repeat again, using red phosphorus instead of charcoal. (10) (11)

Note. Do not handle phosphorus with the fingers.

QUESTIONS

1. What is the grey deposit around the mouth of the test tube?

2. Is oxygen liberated?

Complete the equation: sodium peroxide + water → sodium hydroxide +

3. Complete the equation: potassium chlorate + manganese dioxide → potassium chloride +

4. Is oxygen soluble in water? How can you tell?

5. Describe the test for oxygen.

6. Describe the result.

7. What compound is formed? Complete the equation: carbon + oxygen →

8. Describe the result.

9. What compound is formed? Complete the equation: sulfur + oxygen →

10. Describe the result.

11. What compound is formed? Complete the equation: phosphorus + oxygen →

12. Summarize the properties of oxygen.

●

At this point in the course pupils have not studied symbols and formulas. It is for that reason that names have been used in the equations noted.

In Future Numbers . .

Among the articles which are listed for publication in early numbers are the following:

Illinium

By B. S. HOPKINS, University of Illinois, and L. L. QUILL, Ohio State University.

•

The Catholic Round Table of Science

By REVEREND FRANCIS P. LEBUFFE, S.J., of the *America* press.

•

South American Archaeology

By JAMES C. SAWDERS, Explorer and Lecturer.

•

Nature and Functions of Microbial Life in the Soil

By S. C. VANDECAVEYE, State College of Washington.

•

Collecting Fossils on the Niagara Frontier

By IRVING G. REIMANN, Curator of Geology, Museum of Science, Buffalo, N. Y.

•

Is it Worth While to Teach Science?

By PAUL B. MANN, Evander Childs High School, New York City.

•

Some Aspects of Blood as a Physico-Chemical System

By JULIUS SENDROY, JR., School of Medicine, Loyola University, Chicago.

•

Short Cuts in the Chemistry Laboratory

By WALTER S. LAPP, Northeast High School, Philadelphia.

•

Ignacy Mościcki, the Chemist

By JOHN F. MATEJCZYK, Duquesne University.

•

The Working of Glass

By HOWARD DRAVING, Fisher Scientific Company, Pittsburgh.

•

How Ferns Grow

By W. N. STEIL, Marquette University.

•

Deep Focus Earthquakes

By WILLIAM A. LYNCH, Fordham University.

Habits and Instincts of Ants

Continued from Page One Hundred and Eight

then lays a small batch of eggs, and during eight or nine months nurses them through their larval and cocoon stages and helps the youngsters to emerge from their cocoons. During these months she takes no food, but nourishes herself and feeds her brood at the expense of her fat-bodies and her degenerating wing muscles. The youngsters are unusually small, but they immediately take full control of the nest. They break through the mother's barricade, go forth in search of food and, returning, share it with their mother.

(To be Continued)

LITERATURE CITED

Harris, Jennie E., 1934. "Living Casks of Honey." *National Geographic Magazine*, 66 (2), 193-199.

Mann, W. M., 1934. "Stalking Ants, Savage and Civilized." *Ibid.* 171-192.

Educational Usefulness

Continued from Page One Hundred and Seventeen

and problems of the home, school, and community; and, furthermore, this material must be selected and organized so as to develop in youth those standards, attitudes, appreciations, vocabulary, general ideas, and methods which, after all, constitute the real working equipment of the competent citizen of today.

The Scientific Method and Human Affairs

It is well to examine briefly and broadly at this point the influence of science as method upon human affairs. For many hundreds of years the only method of learning was that which consisted broadly in studying what other men had thought, and trying to think in turn as they thought. This method was essentially the method of argument, as though truth were to be established by vocal means rather than by mental process. About three centuries ago a new method of learning began to be developed, which we know as the scientific method, the chief steps of which, as has been noted above, are: observation, generalization, deduction, verification. Whereas, the traditional method began with reasoning and ended in experience, the method of science begins with experience and reasons through to the truth.

The development of the scientific method ushered in a new and brighter day, and so fruitful has this method been that civilization in the last hundred years has made greater progress in its material aspects, than in all the preceding centuries.

There is still much of the rote method, however, in science instruction. We need a clearer conception of what scholarship means, whether it stands for the acquisition of a definite field of knowledge only, or also for a command of those processes by which the field of knowledge may be enlarged and interpreted in terms of human progress and welfare. Surely the latter conception must control us in our educational practices. Self-education through purposeful activity is the normal condition of growth throughout life, and scholarship that is worthy of the name must be measured in terms of growth in the capacity not only to acquire knowledge but also to interpret and use it for social ends and, perchance, even to enlarge the scope of human knowledge. It is this constructive, creative type of scholarship which has been developed through the use of the method of the scientist, and while the scientific method may be taught and should be followed in many subjects of the curriculum, it is the natural sciences that best lend themselves to its development.

Science and Society

Finally, and most importantly, science instruction therefore must have due regard for the impact of scientific discoveries and inventions upon society. Will these new forces released by science be used to lift mankind to ever richer and higher levels of living or will they be used to destroy civilization as we know it? H. G. Wells has said that civilization is a race between education and catastrophe. If this be so, how important it is that education of every type and grade stress spiritual and social values! Science instruction should help youth to understand something of the omniscience and the unchanging character of God, the same yesterday, today and tomorrow. Means and methods may change, but principles are eternal and unchanging. In adjusting education to meet the needs of a changing economic world, we must also prepare youth to meet the realities and responsibilities of a world of unchanging spiritual values and principles. Science instruction should bring youth closer to God through an understanding of nature's beauties and harmonies and immutable laws, for before all else youth needs God.

Photochemistry

Continued from Page One Hundred and Fourteen

whereby the chain of reactions is broken. Again, if some material is added to the system which will react, for example, with chlorine atoms the chains will again be broken. Various nitrogen compounds are especially efficient in this way. Oxygen which can react with either hydrogen or chlorine atoms acts similarly in breaking chains, thereby reducing the overall efficiency of hydrogen chloride production. Such substances are said to be inhibitors for the reaction.

Numerous practical applications have been found for inhibitors as "preservatives" of, for example, paints, rubber, artificial leathers which normally undergo photochemical oxidation in sunlight by chain mechanisms, the inhibitors breaking the chains and reducing thereby the amount of oxidation. The efficiency of mere traces of such inhibitors can also easily be understood. Thus, in a reaction in which a million chains succeed the primary act, if the reaction is stopped by the inhibitor at this primary act, the reaction rate is cut down to one millionth of that found in the absence of the inhibitor. Thus, it appears that one molecule of inhibitor can prevent the production of one million product molecules.

Two cases have been exemplified with quantum efficiencies of two and approximately a million respectively. Efficiencies less than unity are, as previously stated, usually caused by a too rapid recombination of the dissociation products of the primary act before these products can get far enough apart to act individually in secondary process.

In conclusion, then, the science of photochemistry may be summarized in two laws. First, only the light that is absorbed is effective in producing chemical change, and second, the absorption of light is a quantum process involving one quantum per absorbing unit; the photochemical yield is dependent on the secondary reactions produced by the primary absorption.

Questions

The following questions for discussion have been suggested by Sister M. Geraldine, R.S.M., Mt. Aloysius Academy, Cresson, Pa. What do *you* think?

QUESTION—What are the purposes of laboratory instruction? How may the teacher achieve those aims?

★

QUESTION—Since understanding may exceed skill in manipulation, must we insist upon *all students* assembling apparatus?

★

QUESTION—What is the best technique for obtaining an insight into pupils' thinking?

★

QUESTION—Psychology says to use the native capacities to the utmost. How may this be achieved in the laboratory? By segregation or not?

★

QUESTION—Dewey asks: "Is following a recipe a scientific experimentation?" Is one's mental attitude necessarily changed because he engages in physical manipulation? How then may we turn laboratory technique into intellectual account?

★

QUESTION—If the laboratory is to be the final court of appeal, is it best to know or not to know the outcome beforehand?

★

QUESTION—Should the experiment take place on laboratory days, or at the "psychological moment?"

★

QUESTION—How may the teacher aid and encourage slow students, while fostering the spirit of discovery in the more gifted and ambitious?

★

QUESTION—In the laboratory, are general directions to be preferred to more detailed ones because they induce pupils to work out individual procedures that serve their needs better? or——

★

QUESTION—Should directions in the laboratory be detailed to such an extent as to insure adequate understanding of each experiment?

★

QUESTION—Should much or little discussion precede the experiment—that is, thought questions of selective recall, evaluating recall, etc.?

★

QUESTION—What about drawings? Is a representative drawing necessary to secure accurate observation, precision, and habits of analytical study?

Nutrition Experiments

Continued from Page One Hundred and Four

Six rats and two guinea pigs, obtained from a local hospital laboratory, were used in the project. We had just two animals for each experiment, one receiving the experimental diet, and the other serving as a control. Each animal was placed in a separate cage, and a card was attached showing the name and number of the animal and the diet that was being fed to it.

To give all members of the class an opportunity to take an active part in the project, two students were assigned to each experiment, making eight to a group. Each group was in charge for a two-week period during which time they were responsible for feeding and weighing the animals, cleaning cages and keeping accurate data about the quantity of food eaten daily, gain or loss in weight, general activity, and condition of fur, eyes, etc., at the different stages of the experiment.

We did not use commercially prepared diets in any of the experiments. It would probably be simpler to purchase a quantity of food answering the requirements of the experiments than to select the proper foods at each feeding. However, since the project was to serve not only as convincing evidence of the effect of the nutrient or vitamin on the animal, but also to make the class familiar with foods containing the different nutrients and vitamins, we "made up trays" each day.

The menus depended upon what foods were available (left-overs from lunches, table scrapings, etc). Students used *Tables of Food Values* by Alice V. Bradley and *Feeding the Family* by Mary Schrartz Rose, to ascertain whether or not the food in question is a source of the vitamin with which they were experimenting. In connection with this part of the work the students made charts listing the good and excellent sources of the various vitamins and nutrients.

In carrying out the experiment to show the effect of excluding vitamin A from the diet, two rats, each weighing 55 grams, were selected. The rat on the experimental diet was given meat, potato, flour gravy, and any vegetable not considered a source of vitamin A. The control received the same diet as the deficiency with the addition of some food that is rich in vitamin A, such as a small amount of butter, cheese, etc. The rats ate about the same quantity of food daily, and during the first four weeks of the experiment the gain in weight was about equal. At the end of the fourth week, the control weighed 115 grams and the experimental animal 111 grams. However, about the middle of the fourth week the eyes of the rat on the deficiency diet became inflamed and sore. For the next two weeks this rat was given two or three drops of haliver oil daily. By the end of the sixth week the inflammation and soreness had disappeared, but the sight was gone from the right eye. The left eye again became normal. The feeding of haliver oil was discontinued at the end of the sixth week, and the difference in weight became more marked during the last three weeks of the experiment, the control weighing 138 grams and the deficiency 124 grams at the end of the ten weeks.

The rats selected to show the value of milk in the diet weighed 52 grams at the beginning of the experiment. Both received a sufficient and adequate diet, but the control received in addition 20 cc. of milk daily. At the end of the experiment the control weighed 164 grams and the deficiency 106 grams.

The rats in the third group also received an adequate diet. At the end of the experiment the rat which had received two or three drops of cod-liver oil daily weighed 193 grams, the other 128 grams.

Guinea pigs were used to show the effect of excluding vitamin C from the diet. Rats cannot be used for this experiment since it is believed that they are able to synthesize vitamin C within their bodies. The guinea pig on the experimental diet received whole milk and grains. The control received in addition a quantity of raw vegetables such as lettuce, carrots, cabbage, spinach. At the beginning of the experiment each animal weighed 200 grams. At the end of the third week the pig on the experimental diet became listless and inactive, the eyes dull, and the fur began to fall. Knots could be felt along the spine and at the joints in the legs. There had been a slight gain in weight during the first three weeks, but after that time the animal ate very little and lost weight rapidly. At the end of the fourth week the control weighed 360 grams, and the experimental animal 170 grams. During the fifth week the weight of the latter dropped to 161 grams. At this point a small quantity of lettuce was fed in addition to the whole milk and grain, and recovery began at once.

During the next two weeks the weight increased to 190 grams. During the eighth week fresh food was again excluded and the weight dropped to 175 grams. During the ninth and tenth weeks the experimental animal received the same diet as the control and the weight rose from 175 to 308 grams. The control had gained steadily during the ten weeks of the experiment and at the end weighed 461 grams. Later in the course, when studying the anatomy of mammals, we dissected the guinea pig which had been on the normal diet. All the organs were healthy and well developed, the muscles firm, and the bones straight and well ossified. We then dissected the pig which had been on the deficiency diet, but which now weighed as much as the control and was apparently just as strong and healthy. We found that the spinal column had curved to such an extent that the ribs on the right were so shortened that the lungs, heart, kidneys and other organs were entirely out of position and badly deformed. The stomach was shrunken and the intestines had fallen in the abdominal cavity. There were evidences of internal hemorrhage. The joints were abnormally large and the bones poorly developed. The whole was so striking that it aroused the interest not only of the

Continued on Page One Hundred and Twenty-nine

What the Public Expects

Continued from Page One Hundred and Five

teaching and subject matter should aid pupils in the discovery of the direction of their interests and abilities. Concerted effort should be made to discover, develop, and encourage those who display outstanding talent or promising interest. Our courses of study are not broad enough to permit this in any one science. Pupils may take Latin 1-8, Metal Crafts 1-6, Orchestra 1-6. These are only a few examples. But chemistry, physics and biology are each limited to two semesters. Insufficient orientation is offered in any science. Pupils clamor for advanced work. Should their demands not be met by the introduction of advanced courses of both textbook, and strictly laboratory variety, so that their vocational exploration may be more complete?

Our nation and others are passing through a period of great social and economic change and readjustment. Universally, the people are in a storm of shifting thought and a maelstrom of shiftless thinking. The greatest contribution which science can make today is to stabilize and rationalize thought. Self aggrandizement is motivating the thought processes of too many people. Is it not possible partially to displace loose thinking with scientific method, and to establish scientific attitudes?

Dr. J. O. Frank defines the scientific attitude as—"The attitude which results from a profound belief in the relation of cause and effect. The attitude which enables one to steer directly toward a goal—unhindered by irrelevant or pseudo evidence." If this attitude can be established in the minds of many people; and if in the thought processes of the multitudes science can implant those virtues of open-mindedness, tolerance, suspended judgment, willingness to seek truly and thoroughly for evidence, and to change one's views if the evidence justifies, then our future is secure, and science has made its greatest contribution.

Time will not permit a complete enumeration of the desirable end results which the public has a right to expect of science education. There is one which is looming larger everyday as the hours of labor are decreased: namely, the worthy use of leisure. Other end results of science are the development of skills, abilities, habits, attitudes, discipline, power to interpret, and many others, all of which contribute to the primary purpose of education, Good Citizenship.

Dr. C. C. Furnas, of Yale University writes, "An educated person, to me, is one who has a well rounded knowledge of things as they are, some understanding of things as they were, and a vision of things as they might be." If this may be accepted as a modern, popular, definition of education, no subject in our curriculum contributes more richly than science.

Notes from Experience

Continued from Page One Hundred and Three

> results. In other words, the activity project should be a means toward definite educational goals and not an end in itself . . . and in preparing us to understand what we read. . . . Activity correlated with abstract thinking is the method *par excellence* of scientific discovery, in which observation and experimentation both inspire and verify ideas."

Illustrative material which can be viewed by the whole class, is a very important factor. Here we may be cautioned against perverting the teaching of chemistry into drilling odds and ends. Sometimes it is beneficial to give individual attention to a pupil who will gladly give individual attention to the other members of the class. Field trips are interesting and instructive. The occasional use of the moving picture machine or the stereopticon is to be encouraged. Scrap-books and bulletin boards are not to be overlooked. I recommend an exhibition of the work which is the result of individual talent and accomplishment. I will gladly offer suggestions regarding "Science Night," or whatever you may care to call it. The students always look forward to such a night when all will be expected to contribute wholeheartedly. An exhibition of this kind will arouse their most striking endeavors.

Do not say, "If I devote my time to these means of instruction, I shall be greatly disturbed about covering the ground. I shall never be able to finish the text." I shall never be able to finish the text . . . What sin is there in that? I have not felt as some teachers and pupils do, that the text must be covered from beginning to end, and followed in the exact order given. If you have already developed the "time to be given" attitude, I beg you not to encourage it. Do not let it reach an extravagant form. It is evident that you are not an apostle of change if you assume the attitude, "what was good enough for this year ought to be good enough for next year." You are not a progressive chemistry teacher if you think that long experience obviates the necessity for daily preparation of your subject. I was considerably astonished on one occasion, when a college teacher speaking of "preparation of class work" faced me with this remark: "Surely you do not have to prepare your work any more; you have been teaching chemistry long enough to have it memorized." That professor would have me a firm advocate of everything permanent, of binding agreements, and fixed principles of action. Accordingly, she would not appreciate the remark of Kilpatrick:

> "Each new situation is a problem, demanding its study and thought. We try out our best thought plan; we watch whether it works. Each new program is then an experiment. Amid changing conditions, we live experimentally, must do so."

In his paper entitled *A Preface to the Principles of Student Counseling*, Cowley writes, "Bewildered by the plethora of scientific details and of new administrative techniques, we have lost our bearings." I am clinging to my own particular lamp post, and its dim light in the surrounding shadows lets me see quite distinctly a somewhat pertinent question . . . Why is mathematics such a barrier in the teaching of chemistry?

To those of us who have taught chemistry, the mathematics of chemistry, or even straight mathematics, comes the thought that much of the inaccuracy and failure to solve problems is based upon—What shall I say? Is it English? Or is it the lack of the old-fashioned grammar and mental arithmetic? If we are dealing with the moron, there is nothing much that we can do about it. If the pupil has very little mathematical background, again I say there is nothing much that we can do. If we have made no attempt to point out the simplicity of calculation in elementary chemistry, what can we expect? If it is due to the improper handling of the subject-matter by the English teacher, we are certainly handicapped. But if we are dealing with pupils whose English courses have been adequate, it is our duty to preserve their powers of interpretation; also their ability in self-expression.

Proper note-taking is excellent training in English expression. Too often we find that the statement we emphasized in the lecture, in the class discussion, or in the laboratory, has been forgotten or disregarded. Where is that blackboard sketch which we considered so important in the study of electrolysis? Perhaps it is lost in a heterogeneous mixture of other notes. The pupil did not take time to rearrange and rewrite the outstanding points in the proper form. It is this exercise following the recitation which furnishes the splendid training in English expression.

Experience . . . Let me say in the words of Charles G. Osgood, of Princeton:

> "I have called upon myself, not only for the means of communicating knowledge, but for all the resources of my outfit, all my arts and sympathies and imagination and ingenuity and impulses to self-expression. That I have almost invariably disappointed myself goes without saying. But that did not, and could not, keep me from trying again."

And impressed with the necessity of reviving that first fervor, let me proclaim with William Lyon Phelps:

> "I do not know that I could make entirely clear to an outsider the pleasure I have in teaching . . . In my mind, teaching is not merely a life-work, a profession, an occupation, a struggle: it is a passion. I love to teach. I love to teach as a painter loves to paint, as a musician loves to play, as a singer loves to sing, as a strong man loves to run a race."

A War of Insects

In the interests of science, various species of insects will be pitted against each other in battle before throngs of spectators at the 1939 International Exposition on San Francisco Bay. The exhibit, which will be part of the University of California's $250,000 display in the Hall of Science, will demonstrate how different types of imported insects will attack and destroy native fruit and crop destroying pests.

In fact, the display will be somewhat in the nature of a battle royal, for in one ring Australian Lady Bird Beetle will engage Cottony Cushion Scale, and in another Oriental Chalcid will take on Yellow Scale. Each engagement will be somewhat of a one-sided affair for Australian Chalcid, Australian Lady Bird Beetle and Oriental Chalcid are the undisputed champions at their class and weight, and have overcome the same opponents, represented by different individuals, millions of times.

The display will be actual encounters by live specimens, but the chief spectator interest should attach to the affair between Citrophilus Mealy Bug and Australian Chalcid. The first is the pest that attempted to wipe out California's citrus orchards. It was in a fair way to succeed until Chalcid was introduced into the fray by the University some years ago. Since then Citrophilus has practically disappeared from the map, saving the citrus growers millions of dollars.

The spectacle will be labeled "Pest versus Parasite" and will be for the purpose of showing how biological control can supplement sprays and other methods of ridding orchards of fiercely destructive bugs and scales. While the scales and insects are engaging each other, the spectator will be offered an explanation not only of the contests themselves and what they mean to horticulture, but the manner in which searchers have been sent to countries throughout the world to find the tiny parasites.

Another display will show a collection of beneficial

and destructive insects, and will feature both the dry wood and the subterranean termite, which insidiously undermine wooden buildings and other wooden construction. These will be shown in two large cylinders, and a series of transparencies and a large background panel will tell how they breed, live and destroy.

The honey bee will be featured as one of the chief beneficial insects, and will have his own display. This will show how he gathers the pollen on his legs to deposit it on orchard trees and stimulate fruit growth thereby, how he collects his nectar from plants and weeds to turn it into honey, and how he performs his other wonders.

The night hawk and the horned lark with their protective coloration, will be shown, and the manner in which they blend with differing backgrounds explained. An attempt will be made to show that certain birds have certain variations in coloration which appear to fit the locale in which they live.

The zoological grouping will contain a series of five life groups, mounted against an appropriate background, displaying the five major zoological life zones in California. These zones are the Lower Sonoran, in the vicinity of the San Joaquin River, the Upper Sonoran of Mokelumne Hill, the Transition Zone, near Silver Lake Hill and the zones high in the Sierra. It will be explained how the sojourner may pass from one of these zones to the other, covering a considerable sweep of territory, or how he may climb one single mountain and find them all there within more or less regular boundaries.

All of the individuals in the insect display will be live specimens, but the animal and mammal displays will be mounted. The display details are being directed by the Department of Zoology and the Museum of Vertebrate Zoology and is expected to be a revealing spectacle of the life and habits of much of California's wild life and how the University is attempting to turn these factors to the service of man.

Nutrition Experiments

Continued from Page One Hundred and Twenty-four

biology class but of the entire student body and faculty as well. At the end of the experiment, vitamin C and scurvy were no longer just "terms" to these students, nor was the study of nutrition in general just another chapter in the book.

These experiments are but four of many, simple enough to be practical in a high school biology course. They are the answer to the quest for a teaching device that will arouse the interest and enthusiasm of the students, sustain their interest, and show them the connection between the subject matter of the textbook and the wider and more direct experiences of everyday life.

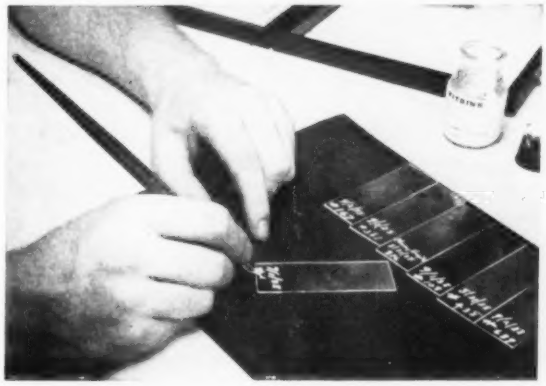
Examination Questions

Continued from Page One Hundred and One

Would any of these methods be likely to affect your attitude toward the papers? Why?

9. If you find several papers containing identical answers, and the answers are erroneous, what is the best procedure?

10. What use do you make of a set of examination papers after you have finished marking them?



FOR MARKING GLASSWARE

Writing on glass with "vitrink" is similar to writing on paper with ordinary ink. It dries in a few minutes and becomes very hard over night. It resists moisture and acids, but it can be removed by hot water and a stiff brush. Illustration, courtesy of the Fisher Scientific Company.

Modern Map Making

Aerial mapping is now reaching a stage of accuracy and speed which is destined to relieve the surveyor, with his transit and theodolite, of much of his roughest work. Jobs that would have taken him weeks can now be accomplished in a few hours by the use of a plane, a camera, and a new stereo-mapping projector which is now being made by the Bausch & Lomb Optical Co.

An automatic camera in the plane, shooting at regular intervals, makes pictures a mile apart. Terrain features are thus seen from different positions in succeeding photos just as the two eyes seeing things from slightly different positions get depth perception. If the two eyes respectively see the views taken a mile apart, the effect is as if the mapmaker had eyes a mile apart.

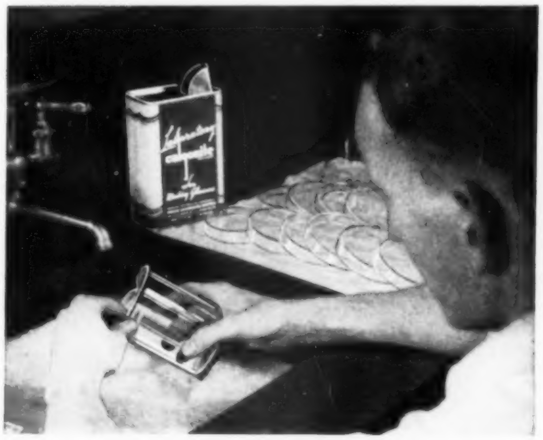
To achieve this, the 7" x 9" film negatives, each covering from the usual altitude of 20,000 feet, about 13 square miles, are printed on small glass plates about the size of two special delivery stamps. The utmost exactness is required in the adjustment of the instruments since a difference of one ten-thousandth of an inch might mean a difference of feet in the field. From the glass plates the picture is projected down on a drafting table by two adjacent projectors operating in red and blue light respectively.

With six separate adjustments on each projector set to produce exactly the same angular position that the camera occupied when making the corresponding negative, the mapper, wearing spectacles with one red and one blue lens, suddenly sees a single illusory three-dimensional model of the terrain on the table before him. The effect is so realistic that he may feel an impulse to pat the top of a smooth hill or prick his finger on a telephone pole.

To draw his map he moves across the drawing paper a fixture containing an illuminated pinhole mounted directly above a pencil. With this point of light set at a given height, the mapmaker moves the fixture about so as to keep the point in contact with the surface of the illusory ground. The line thus traced passes through all points where the ground is that high, resulting in a contour map.

The stereo-mapping projector will be used by the U. S. Army Air Corps, for military work and by government agencies and private mapping outfits for forest surveys, estimating timber stands, laying out logging areas, locating dam sites and camps and making topographic surveys.

For Cleaning Glassware



"Calgonite" is the latest improvement in the washing of laboratory glassware. A chemical water "normalizer," it produces water of "rain barrel" softness. It removes blood, media, grease, and oil. It does not produce a scum of calcium and magnesium salts when added to hard water. Illustration, courtesy of the Fisher Scientific Company.

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1938

Articles are listed under authors' names. Book reviews are listed under the name of the author of the book. (R) indicates a book review. The name of the reviewer follows in parentheses.

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